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How to *Perpetuate* Your *Earning Power*

By WALLACE AMES, *Financial Editor*

I

"GOOD news, Laura," announced Dwight Miller, coming home from the office early Wednesday, the night before Thanksgiving. "My salary will be increased to $5,000 the first of the year. That makes the fifth year in succession that I have started the New Year with a boost in pay. If these raises keep coming with their accustomed regularity we'll soon be drawing more pay than we know how to spend."

Dwight Miller is a typical example of a young man, whose scale of earnings is on the incline.

II

"Here's your commission statement for the year," said the sales manager to Grant Walsh. "It shows you a little overdrawn. Your drawing account amounts to $8,000 and total commissions on sales, $7,350. Do you think you can make this up next year, or had you better reduce your drawing account a little?"

Being honest with himself, Grant Walsh felt none too sure he could do better during the coming year than the one just ended. He was past the 50-year mark. He wasn't able to work his territory as hard as he did a few years back.

Grant Walsh is a typical example of the man past middle life, whose scale of earnings is on the decline.

* * *

According to statistics the average man's earned income increases rather steadily until he reaches the peak of his earning power somewhere, say, between 48 and 57 years of age. Of course a statistical rule will not apply strictly to any particular individual. For a variety of reasons any one individual's earnings may fluctuate upward or downward from year to year. The proprietor of a business may continue to increase his income steadily up to the year of his retirement. But there is no disputing the fact that the average man's earning power is on the incline up to a certain point in his business life; and then starts on the decline.

What could Grant Walsh do to stem the ebbing tide of earning power? Very little, unless he had prepared for it during his earlier and more fruitful earning years.

What can Dwight Miller do now to prevent finding himself in Grant Walsh's predicament at some future time? The following example will show how he, or any man, can perpetuate his income,—have an investment income to fall back on when his earned income starts declining.

* * *

Assume that Mr. Average Man starts earning $2,000 a year at age 25 and that he does these things: (1) gets a $250 yearly increase each year, up to age 50; (2) saves 10% of his income and invests it at the end of each year to earn 6%; (3) re-invests his interest, together with each year's savings; (4) when his earned income starts declining after age 50, that he uses enough of his investment income to replace the decline in his earned income.

To work the case out completely let us assume that between ages 51 and 52 Mr. Average Man's earned income begins declining at the rate of $250 a year, and after age 61 it drops $500 a year. The following chart shows the rise and fall in his annual earned income between ages 25 and 65.

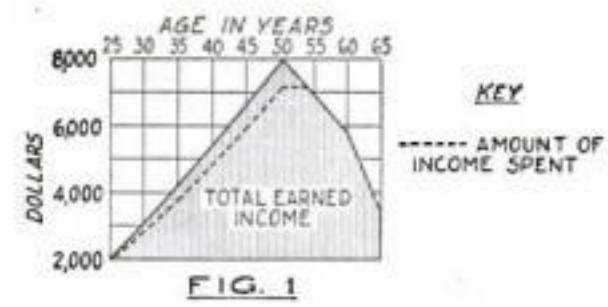

FIG. 1

Note the dash line. It represents the amount of earned income spent; the balance is invested and re-invested so as to earn the equivalent of 6% compounded annually. The most that Mr. Average Man has spent out of earned income in any year is $7,200. Not until his earnings fall below $7,200 does he begin to spend any part of his investment income. Even then he draws out only that amount of investment income which will bring his total spending up to $7,200.

As a result of Mr. Average Man's easy investment program of 10% a year, he has sufficient independent income so that from age 50 on he can continue to spend $7,200 a year, even though he earns less.

In the following chart again note the dash line, and the dark area representing investment income which replaces earned income.

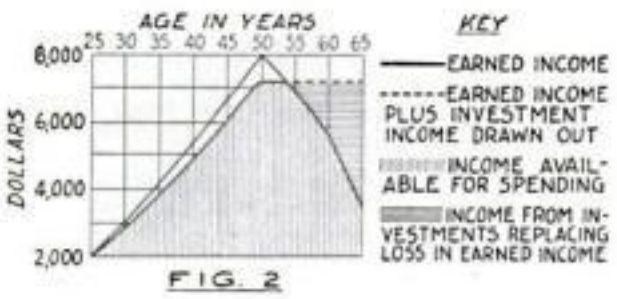

FIG. 2

The black area in the following chart shows the amount saved yearly; the dash line shows the cumulative total amount saved; the solid line shows the yearly gain in total worth, gained through interest on investments; and the dot-and-dash line shows the amount (Continued on page 5)

How to Perpetuate Your Earning Power

(*Continued from page 4*)

of investment income spent after Mr. Average Man has ceased to save out of earnings.

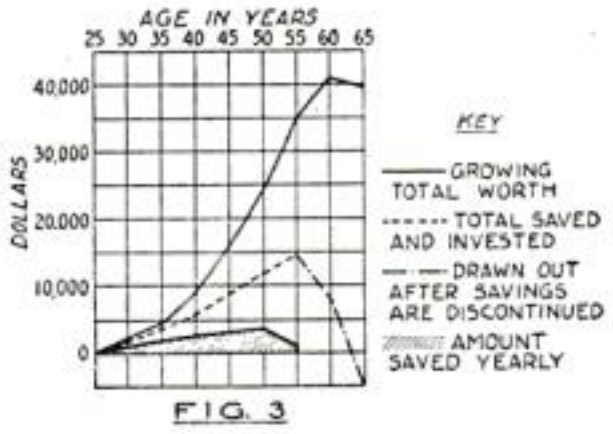

FIG. 3

Following is a summary of the mathematical results of this easy program.

Age Period	Amount Saved	Cumulative Total Saved	Investment Income	Total Worth
26–30	$1,250	$ 1,250	$ 214	$ 1,464
31–35	1,875	3,125	1,057	4,182
36–40	2,500	5,625	2,941	8,566
41–45	3,125	8,750	6,429	15,179
46–50	3,750	12,500	12,278	24,778
51–55	1,450	13,950	21,119	35,069

Age Period	Amount Spent from Investment Income	Investment Income	Total Worth
56–60	$ 4,750	$32,453	$41,653
61–65	13,500	44,256	39,956

Between ages 26 and 55, Mr. Average Man saves $13,950; between 56 and 65 he draws out $18,250 or $4,300 more than total savings. As his savings earn $44,256 he has $39,956 left after spending $4,300 more than he put in. (*Continued on page 6*)

A Service for Readers

THIS Financial Department is to help readers in the establishment of proper financial programs at the beginning of their business careers; it assists those who have accumulated money in the proper investment of it.

The Editor of this Department is an authority on investment matters. He is ready to aid in personal investment problems. Advice will be gladly given regarding the proper investment of funds and proper plans of saving.

Address your inquiries to Wallace Ames, Financial Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York. While investments obviously cannot be guaranteed by the Publisher, every effort will be made to insure that only advertisements of absolutely reliable companies are accepted.

How to Perpetuate Your Earning Power

(*Continued from page 5*)

At 6%, $39,956 yields an annual income of $2,397 on which to retire.

The most powerful forces in getting ahead are (1) regularity in savings and (2) re-investing interest so that it will compound itself. While $800 was the greatest amount saved in any one year, Mr. Average Man's retirement income is $2,397.

POPULAR SCIENCE MONTHLY suggests that every reader start the New Year with a program to save at least 10% of his earned income, on a re-investment basis, so that he may perpetuate today's earning power through later years.

To Help You Get Ahead

THE Booklets listed below will help every family in laying out a financial plan. They will be sent on request.

"How to Build an Independent Income" is the title of a new booklet by the F. H. Smith Company which explains conclusively how people of moderate means may obtain financial prosperity. **"55 Years of Investment Service"** describes the history of progress of the F. H. Smith Company as well as making an attractive suggestion in first mortgage real estate bonds. May be obtained by addressing the home office of The F. H. Smith Company, Smith Building, Washington, D. C.

The House Behind the Bonds reminds the investor of the importance, not only of studying the investment, but of checking up the banker who offers it. Address: Fidelity Bond & Mortgage Co., 1188 New York Life Building, Chicago, Ill.

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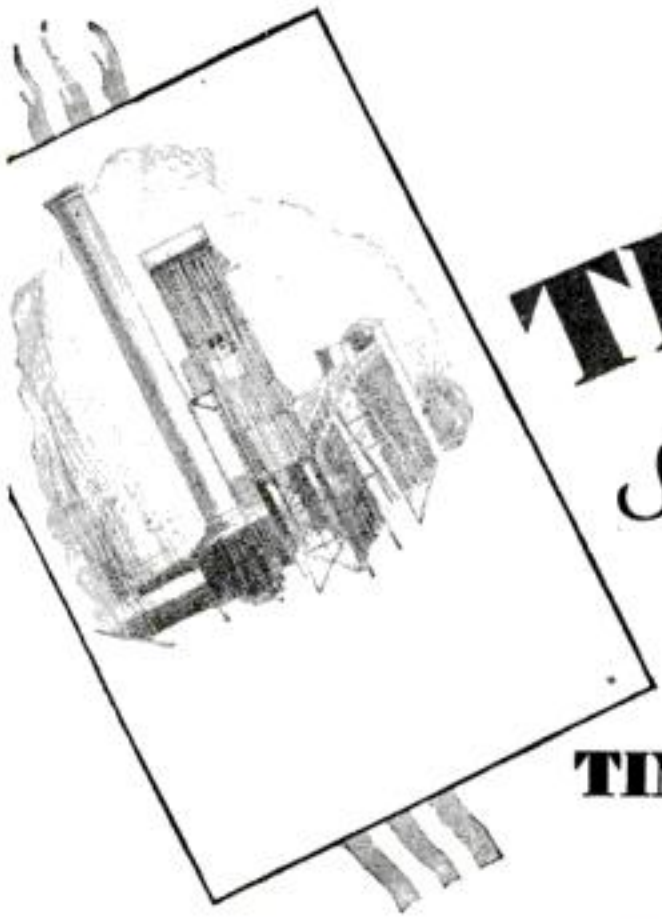
How to Retire in Fifteen Years is the story of a safe, sure and definite method of establishing an estate and building an independent income which will support you the rest of your life on the basis of your present living budget. Write for the booklet to Cochran & McCluer Company, 46 North Dearborn St., Chicago, Ill.

How to Get the Things You Want tells how you can *use* insurance as an active part of your program for getting ahead financially. Phoenix Mutual Life Insurance Company, 328 Elm Street, Hartford, Conn., will send you this booklet on request.

The Guaranteed Way to Financial Independence tells how a definite monthly savings plan will bring you financial independence. Write for this booklet to Investors Syndicate, 100 North Seventh Street, Minneapolis, Minn.

The Making of a Good Investment tells how 6½% can be made on investment in First Mortgage Bonds in units of $50, $100, $250, $500 and $1000; how the bonds are protected and how simple it is to purchase them. For a copy of this booklet address United States Mortgage Bond Company, Limited, Detroit, Michigan.



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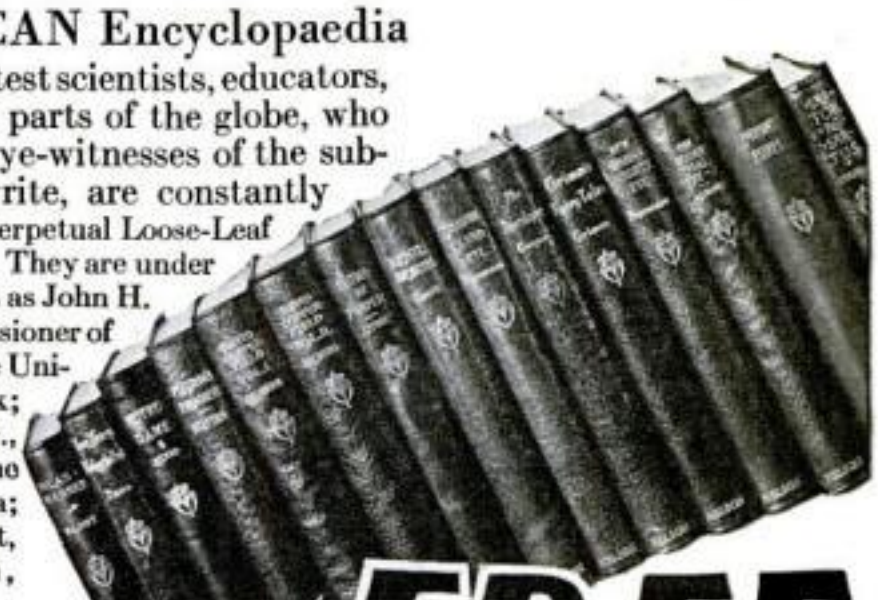

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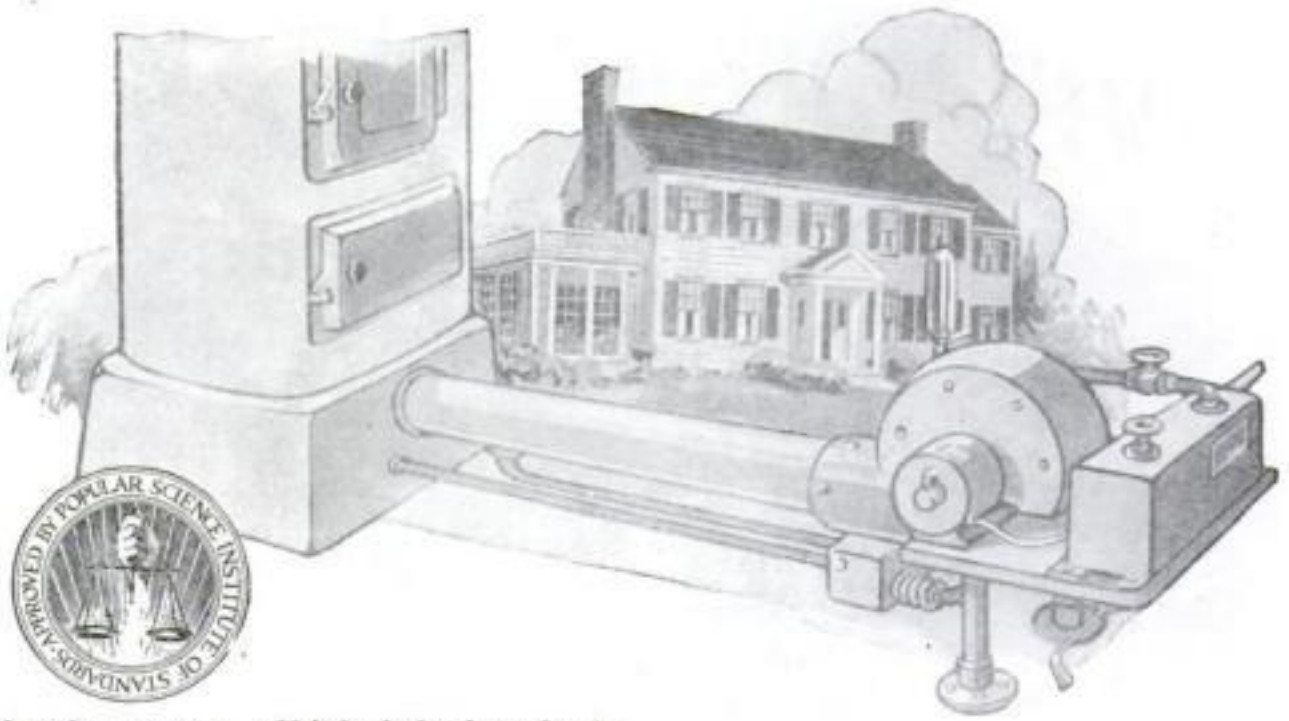
Pulling the Magic Heat Switch

Features of Heating with Oil That Have Made So Many Home Owners Turn to This Ideal Modern Fuel

By

COLLINS P. BLISS, M.A.

Director, Popular Science Institute of Standards



"AND that's what decided me on oil heat." My friend had just finished describing an evening at a neighbor's home when the uncertain fall temperature had taken a characteristically sudden drop. His host's method of restoring comfort had been to pull a switch and start the oil heating apparatus going. No shivering, no putting off the disagreeable task of building a furnace fire—just the pulling of a switch was all that had to be done in that home to start the heating system for the season.

It is the automatic heating service which goes with oil burners of the better type that has made so many home owners switch to oil as fuel. Why tend a furnace, why shovel ashes, and why keep watching a thermometer and regulating house temperature when a good oil heating device will do it all? These are the features that appeal, and these are the features that make an investment in oil heating equipment a worth while one. An oil heater may or may not bring saving in fuel cost—and more probably *not*—but buying oil heating equipment involves something more than the purchase of a device which makes heat through use of another type of fuel; it means the buyer is securing an automatic heating service, besides.

EVERYONE who has an adequate heating system, electric supply, and lives in a locality where both the proper grade of oil and oil heating service are available, can take advantage of this modern method of heating. The change from coal to oil as fuel does not involve particular difficulty or delay and can be made in winter.

In this connection there is one point that should be stressed, however, and that is that an oil heater is no cure-all for the ills of a poor heating system. No matter how efficient the oil heating device, it cannot make up for deficiencies in the heating system of which it forms a part. If that third-story north room is hard to heat with coal, matters will not be improved much through the change to a different kind of fuel. An oil heater is just the heat producing mechanism for the rest of the heating system, and that heating system has to be put in first-class operating condition before it can coöperate properly with a good oil burner.

But it is hard to equal the wonderful results that come from the proper installation of an efficient oil burner in a good heating system. Chief of the benefits is the maintenance of house temperature within a two-degree variation from any set temperature from fall until spring, and without attention. Most of the better burners now on the market are fitted with automatic control equipment that regulates performance in a way no human being in constant attendance could ever do, for the human body will not recognize a difference of one degree or less.

THE control device not only provides an even temperature and freedom from attendance, but also promotes the efficiency of the heating system. The oil burner operates only when necessary to keep the temperature at the desired level. If the outdoor temperature goes up, the control device sees to it that no more fuel is used than is necessary to keep the house at the temperature the owner has designated. Truly a wonderful fire tender, this device! Due to such regulation, real saving in fuel is effected especially in changeable climates and in fall and spring. In fact, such weather is real oil burner weather, for it is then that oil heating equipment reaches its peak of convenience.

The automatic service feature of oil heating equipment makes it a particular boon in homes where furnace attendance falls to the lot of the women members of the family during most of the day. And, again, it is especially appreciated when, after a night or a week-end away from home, the owner comes back to a comfortable house with no burnt-out fire nor broken water pipes as payment for his absence. Also, it is the pleasure and privilege of the oil burner owner to wake up in a warm house. He may set a dual-temperature thermostat so that the house temperature is automatically lowered during the sleeping hours and increased in the morning. He can, by the turning of a knurled knob, establish temperatures at any point between 55° F. and 85° F. Or, he can maintain his house at one temperature from October until May.

As for care, the oil heater requires none and should get none from the home owner. Just as your automobile requires some mechanical adjustment from time to time, so the oil heating device may need the attention of the service man at rare intervals, but a good oil heater will not require as much attention in a five-year period as the average coal furnace gets in five winter days.

These, then, are the reasons that my friend is preparing to put oil heat in his home, that his neighbor has already done so, and that a chain of homes from one coast to the other are provided with oil heating equipment.

Readers of POPULAR SCIENCE MONTHLY who are considering this method of heating can secure definite help from the Popular Science Institute of Standards. Best advice can be given when details are supplied regarding the following points: (a) number of rooms in house; (b) type of heating system; (c) amount of coal burned annually; (d) electricity or gas available.

Building Problems

The Popular Science Institute has enlarged its activities to include a service to readers in connection with building problems. If you are building or contemplating building, we will gladly answer any questions on which you seek information.

Insulation

One of the first activities of the Popular Science Institute has been the investigation of all facts regarding insulation. Over 2,500 building contractors and architects have supplied authoritative information on the question—all information available from all sources has been secured.

The Popular Science Institute stands ready to answer specific questions on Insulation—and a comprehensive booklet is now being prepared entitled "Insulation in Building Construction." POPULAR SCIENCE INSTITUTE, Readers' Building Service Bureau 250 Fourth Avenue, New York City.

This *grainless* wood offers new profitable opportunities for industrial progress

Each day new uses are being revealed for this product, because of its unusual workability, uniform strength, high resistance to moisture and other astounding advantages. Write today for a generous sample—sent free—and test for yourself its remarkable possibilities.

THEATRE SEATS

Industrial America . . . quick to grasp the importance of a product that would bring about significant manufacturing improvements and substantially lower operating costs . . . has already uncovered startling uses for Masonite Presdwood, the grainless wood board.

This easily worked material is made of genuine wood, torn apart and put together again without chemicals or any other foreign binders. It does not damage tools and will not crack, check, split or splinter. It is absolutely grainless.

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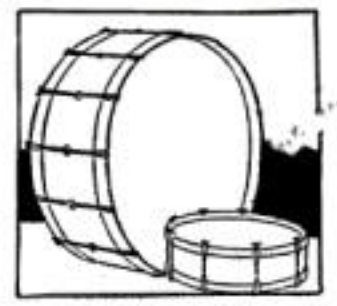
And when you have proved these facts for yourself, you will quickly realize why industry after industry has turned to it to reduce costs, improve a product or speed up production.

There is little waste with Presdwood. It is easily handled. It can be used on any woodworking machine; it can be cut out, punched, die cut and scraped. It is perfectly smooth on the face side and requires no paint to withstand the elements.

New uses discovered daily

Each day new uses are being discovered for this remarkable product. Each day enthusiastic letters of praise are being received from a wide range of industries.



DRUM SHELLS

Motor boat hulls, truck bodies, tension boards for radio speakers, portable billiard tables, toys, bedroom screens and fire screens, store fixtures and table tops, show window flooring and show cases, interior finish and office partitions, radio boxes, paneling, closet lining and display booths, breakfast nooks and kitchen cabinets, signs and cut-outs of all kinds, suggest some of the many and varied uses of Presdwood.

Several railroads are now using Presdwood as paneling in their new Pullman cars. A box maker turned to Presdwood after a box of this material had withstood being dropped 1942 times when a similar box of conventional material failed after 871 drops. The Chicago Art Institute is using Presdwood as a backing to protect rare works of art. Campers' tables, safety wheels for bathing beaches, bread boxes, dust arresters for journal boxes and lining for elevator and ventilator shafts, suggest more of the seemingly endless uses of this grainless wood board.

Send for your sample

If discovering new and profitable applications for a product of unusual workability intrigues you, do not fail to write today for your free, generous sample of Presdwood. The chances are it will enable you to learn how to make a worthwhile improvement in some product.

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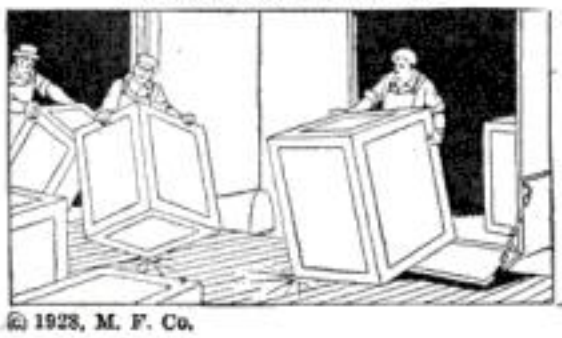

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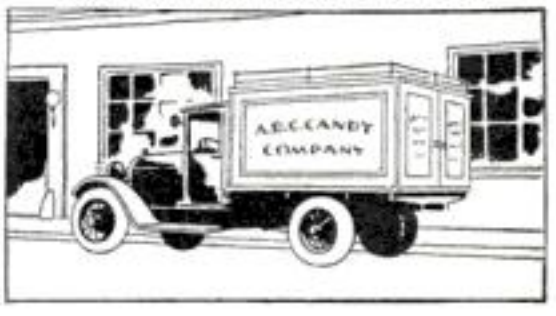

Our Readers Say—

From a Hero Worshipper

"I SEE your announcement of the forthcoming great series of articles on the Wright brothers, 'Fathers of Flight.' No doubt the author, Mr. McMahon—whose articles on housebuilding in your magazine I read diligently—will boost Orville and Wilbur clear up to the top floor of immortal fame for their services to civilization.

"Some forty years ago one Gottlieb Daimler did a big thing for the world by fathering the internal combustion engine that led to the motor car—and in his immortal combusting was followed by Selden, Ford, and the rest. Last year motor cars murdered more than 26,000 innocent American people. The average toll for every 125-mile stretch of roadway is one person killed and twenty-nine injured.

"Twenty-five years ago Orville and Wilbur Wright put the first flying machine into the air at Kitty Hawk. Today every week-end ushers in a Bloody Sunday in the sky. Monday morning papers recently told of eight deaths and eleven injuries in airplane crashes in a day.

"I ask you—isn't it wonderful? I trust that Mr. McMahon, in his own inimitable way, building a place for the Wright brothers in the Hall of Fame, will not fail to mention all the great things these inventors have done for mankind—especially in increasing the death rate."—S. T. R., Jr., Washington, D. C.

A Remarkable Flying Field

"IN HIS article, 'Cities in Race for Airports,' Robert E. Martin mentioned Rockville Centre, a Long Island village, as one community which recently dedicated a local airport. I wonder if he happens to know what an unusual location this airport has.

"It is on the bed of a huge reservoir that turned out to be a flivver. Years ago, city engineers (I believe it was in Brooklyn, N. Y.) designed and built this reservoir as part of the city water supply system. A great oval-shaped dike of earth was thrown up and faced with stone blocks to trap the waters of a stream. When the reservoir was completed they turned the water in. The sandy bottom of the big bowl leaked like a sieve!

"For years the reservoir and its works lay untouched, overgrown with trees and brush, a ghastly reminder of engineering stupidity. To the town boys it was known as the 'dry res.'

"And then someone had the big idea. An airport! The leaky bed, when shorn of its overgrowth, offered a broad, level flying field. Acres of waste land at last found a use. Perhaps the example set by Rockville Centre may lead other communities to dedicate their waste land to American progress in the air."—D. S. B. Rockville Centre, N. Y.

What Is Your Reason?

"EVERY month I look forward to the day your magazine appears on the news stand. I am well along in years, but I believe I still have 'divine curiosity.' Without that, a person becomes a parasite, living on the thinking of others instead of doing some of his own.

"Your magazine, with all of its new ideas and inventions and suggestions, is the best food I know for original thinking. It stimulates the mind and suggests new roads for it to explore. That's why I read POPULAR SCIENCE. I'd like to see letters from other readers telling why they read it."—O. B. B., Winfield, Kans.

What! No Stockings?

"I WISH all the success in the world to those two young inventors who devised the $20,000,000 stocking mender. But I can't help thinking—wouldn't it be just luck, now, if all the women decided to take off their filmy hosiery altogether? I've seen it done."—CRABBY, Denver, Col.

What's Wanted

"I HAVE read your magazine for the last three years and found it to contain many valuable articles, but not enough chemistry. Chemistry is a subject of importance in the industrial system of today, and I think that a set of experiments that would illustrate simple chemical laws and reactions would be a valuable addition to your magazine."—M. S., Kaukauna, Wis.

"Again you refer to the existence of a 'large book' in your offices, made up of 'suggested inventions' from various of your readers. But what good does this do all but a small number of your readers, many of whom must be inventively inclined, and so interested in such things? Why don't you continue the practice of publishing, each month, excerpts from this volume?"—G. M., Salt Lake City, Utah.

"Sailing On and On"

"THE article entitled, 'What Is Invention?' claimed much of my thought. However, the writer failed to solve the problem. May this old retired teacher venture—in her lame way—to give her viewpoint?

"Invention is creation, humanly visualized, but direct from the mind of the Almighty Creator. He pays out such knowledge to those fitted to understand it, perhaps not fully, but partly—to those sufficiently in tune with Him to understand, perhaps, how to begin a new subject. One person is not always delegated to carry a thought to full completion, and others 'pick up the lines' where left and 'sail on and on.'"—F. F. L., Worcester, N. Y.

Applied Mechanics

"OUR anti-moon-rocket friend asked, 'Where in empty space will they get their resistance required to drive the rocket on?' If he will go back to the second of Newton's laws, he can find the answer to his own question. This law states that the acceleration experienced by any given mass is proportional to the force applied to that mass.

"The gases ejected by the nozzles of a rocket come forth at a high rate of speed, relative to the rocket. Since the internal force of the gases gives them their high velocity, this force has to act on something. The 'something' is the front part of the explosion chamber. Using this as a base, the gases push themselves out into space. Here is where Newton's third law of motion should be quoted. Since action and reaction are equal and opposite, if the gases push on the rocket, the rocket pushes on them, and thus is kicked forward."—W. D. G., Jr., East Orange, N. J.

Wouldn't It Have to Stop?

"TO THE question, 'If a shaft were drilled down straight through the earth, if such a thing were possible, and something dropped into it, would this something stop midway between?'—you gave the answer, 'Yes, it would.'

"I am inclined to doubt this. I'd answer that question as follows: 'Say a ball was dropped into this shaft. On approaching the center of the earth it would have its velocity increased, while the gravitational attraction for the ball would be decreased. At exactly the center of the earth there would be no gravitational attraction for the ball (since this attraction is greatest at the earth's surface and diminishes as we move inwardly), but the velocity gained by the ball would carry it past the center.

"After passing the center, the ball's velocity would be diminished because of the gravitational attraction pulling it back toward the center. When the opposite side was reached the ball's velocity would be zero and the gravitational attraction for it would be the greatest, so a duplication of this process would take place."—J. M. S., Framingham, Mass.

Step Right Up, Folks

"THE man with the largest bump of curiosity I ever heard of is a scientist over here by the name of A. S. E. Ackerman. Addressing the world at large, he wants to know if there is any man alive who has ever dipped his hand into molten lead and pulled it out again. His reason, he says, is that he wants to settle the truth or falsity of theories advanced by certain modern physicists that such a feat could be performed without injury.

"Certain ancient records, it seems, tell of heroes of old who boasted of plunging their hands into searing liquid metal without scorching them. Some present-day scientists claim that it might have been possible, due to moisture in the skin and other reasons. But I notice that none of them, Mr. Ackerman included, has volunteered to try it.

"Seeing that you Americans have the reputation of being tough skinned, I thought that some of you might step forward and help the gentleman out."—R. N., London, England.

Action in Colors

"WHETHER you receive expressions of appreciation from subscribers for the very fitting color plates of your front cover I do not know. There's an up-to-dateness about the covers. They spell action, and POPULAR SCIENCE stands for latest advances in action."—J. F. L., Worcester, N. Y.

Reap Big Dividends from this Investment in Tone Quality

A Thordarson Power Amplifier (Home Constructed) Will Transform Your Radio Into a Real Musical Instrument

WITH the insistent demand for quality reproduction, power amplification has become a vital radio necessity. Today, it is hard to find a radio set manufacturer who does not employ one or more power tubes in the output stage of his receiver.

There is no need, however, for you to discard your present radio instrument in spite of the fact that it is outclassed by newer models with power amplification. You can build a Thordarson Power Amplifier which, attached to your receiver, will provide a fullness and richness of reproduction that will equal or surpass the finest offerings of the present season.

Thordarson Power Amplifiers are exceedingly easy to assemble, even for the man with no previous radio experience. Only the simplest tools are used. Specific instructions with clear-cut photographs, layouts and diagrams insure success in home construction.

Whether your present receiver is factory made or custom built one of these amplifiers may be attached with equal ease. In fact, most Thordarson Amplifiers require absolutely no changes in the wiring of the receiver itself, attachment being made by means of a special plug which fits the last audio socket of the receiver.

Thordarson Power Amplifiers for the home constructor and professional set builder range from the simple plate supply unit up to the heavy-duty three stage units employing the 250 type power tube in push-pull arrangement. These power amplifiers cover the requirements for every purpose and every pocket-book. They may be used with any type of horn, cone or dynamic speaker.

With a background of over thirty-three years manufacturing quality transformers, it is only natural that so many manufacturers of receiving sets of undisputed superiority have turned to Thordarson as the logical source of their audio and power supply transformers. The discriminating home constructor will do well to follow the lead of these manufacturers when buying his power amplifier.

Write to the factory today, enclosing 25c for the new "Power Amplifier Manual"—just off the press.

New!

No Amateur or Professional Set Builder Should Be Without This Book—

"POWER AMPLIFIER MANUAL"

A simple, yet complete, treatise on the subject of audio and power amplification, including full information on building, servicing, and testing power amplifiers in general. Also contains detailed specific construction data on twelve individual power units, with clear-cut layouts and diagrams of each.

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INCREASE COMFORT ... SAVE FUEL

Wise home owners nowadays are insisting on insulation as a standard item of building . . . only the indifferent ones are still willing to live in old-fashioned heat-leaking houses.

Celotex makes it easy for *every* family to enjoy the benefits of insulation . . . it brings greater comfort, health and fuel-saving to old homes as well as new.

Celotex shuts out winter cold . . . reduces sickness by guarding against dampness, chill and draughts.

It lowers fuel bills twenty-five per cent or more by holding furnace warmth where it belongs—*inside* walls and ceilings.

In summer Celotex stops scorching sun heat on the *outside*, making your rooms cool and delightful.

Millions of tiny sealed air cells give Celotex such a high insulating efficiency that it is used in modern refrigerator cars and household refrigerators, as well as in nearly a quarter of a million homes!

Celotex also has great structural strength. It comes in big, light cane-fibre boards that *build* as well as insulate—that *replace* other materials. So your insulation costs little or nothing extra.

You can use Celotex Standard Building Board for sheathing; for lining basements, attics, roofs and garages. And for inside walls there is Celotex Lath, a plaster base especially designed to eliminate cracks and lath marks . . . that gives permanently smooth plastered surfaces.

Use Celotex in your present house for transforming unused attic space into extra bedrooms . . . for converting the basement into living quarters or a recreation room . . . for changing open porches into sun parlors.

Ask your builder for additional information on Celotex. Or write direct to us and ask for the Celotex Book, "Year 'Round Comfort and Fuel Saving."

Celotex Insulation brings you new home enjoyment and economy, undreamed of by other generations

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INSULATES AND BUILDS STRONGER-QUIETER
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AND SAVES FUEL

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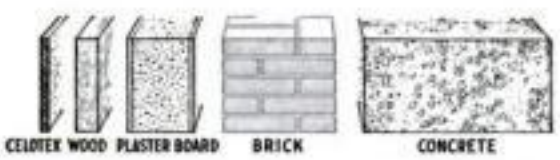
When you buy a house look for this sign . . . it is your assurance of greater home comfort

The Celotex Company, Chicago, Illinois. In Canada: Alexander Murray & Co., Ltd., Montreal. All reliable dealers can supply Celotex Building Board and Celotex Lath.



These Sections Are of Equal Insulation Value

Relative heat-stopping values

Cross-sections show why Celotex is needed as insulation back of wood, brick, plaster and concrete . . . As a heat stop, Celotex is 3 times as effective as wood; 8 times, plasterboard; 12 times, brick; 25 times, concrete.

(Data compiled from tests published by the American Society of Refrigerating Engineers.)

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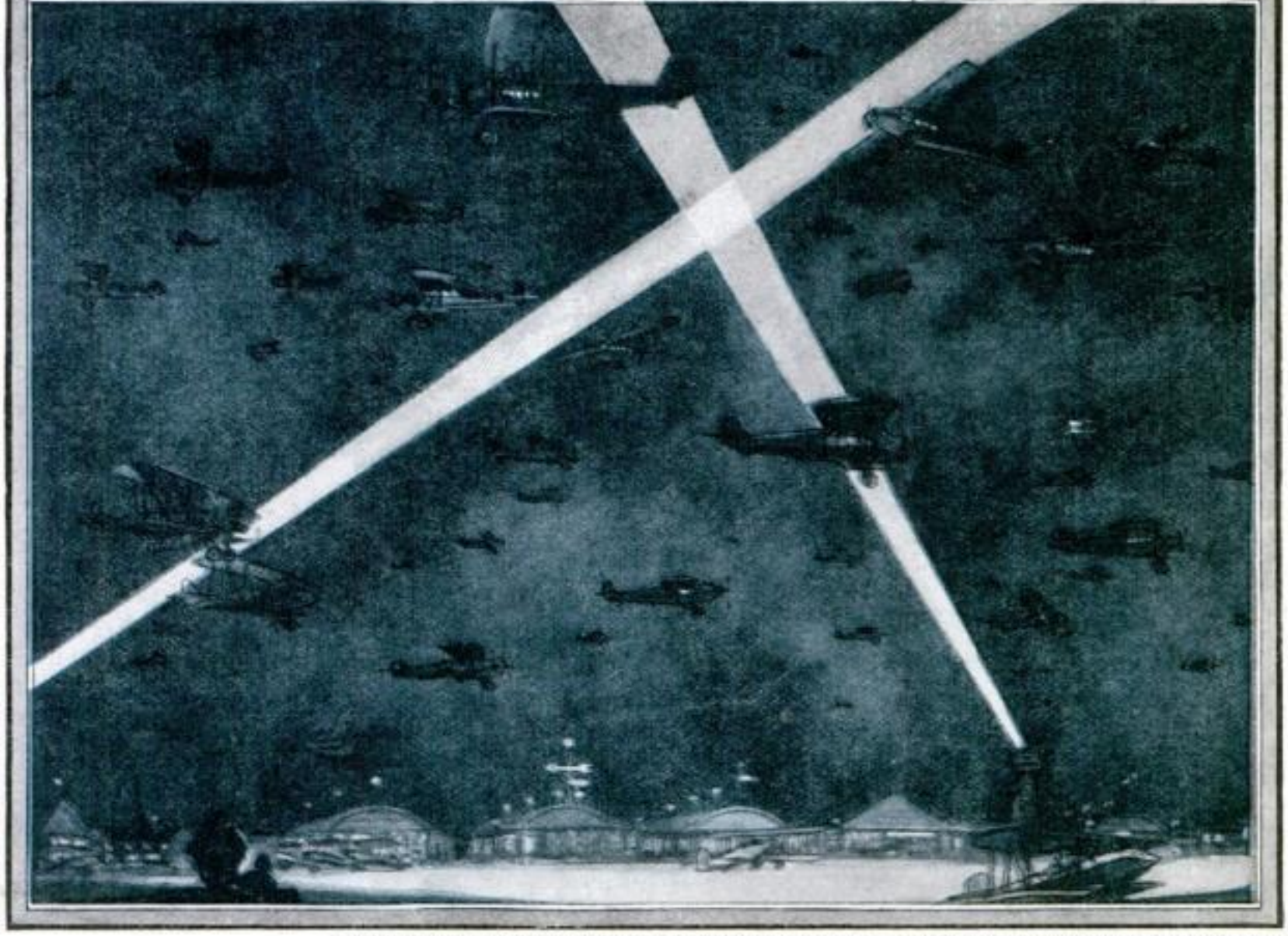
Popular Science
MONTHLY

JANUARY, 1929 SUMNER BLOSSOM *Editor* VOL. 114, NO. 1



Tomorrow we can see the sky roads crowded with planes—all born of the Wright brothers' immortal discovery.

At Last—The Inside Story of Wilbur and Orville Wright,

The Real Fathers of Flight

JUST twenty-five years ago the first frail airplane was launched—and, until now, the complete, intimate story of its creators never has been told. It was Mr. McMahon's privilege to hear this story from Orville Wright himself, and to see private diaries, letters, and telegrams telling of the two brothers' dramatic struggles to fly. Here it is repeated to you—the most thrilling narrative of its kind ever published.

By JOHN R. McMAHON

THE sky is alive with winged craft. They dart through clouds and slide across the open blue. At night, unseen, they murmur their progress along starry pathways. They wend to distant cities. They cross the Atlantic and Pacific oceans, the continents of Asia and Africa, the North Pole and—soon—the South Pole. They make pictorial map surveys, patrol forests against fire, maneuver in military hosts, bring first aid to regions of disaster, poison insects in field and orchard, carry machine parts to remote mines and this article to the printer, transport people and cash along with urgent letters.

Yet—think of it!—a quarter century ago no airplane existed!

Man flew for the first time on December 17, 1903, when Wilbur and Orville Wright, Americans, launched themselves in the air at Kitty Hawk, North Carolina. They discovered the secret of flight, and their principles are embodied in every practical airplane known in the world today. They are the immortal pioneers who lifted man from the earth and gave him another dimension to move in with freedom surpassing that of the birds. The airplane has been improved but not essentially changed from the original "flying machine" devised by the brothers Wright.

These are facts accepted by a minority of informed persons. For the public at large the Wrights' title is under a cloud. Indeed many intelligent folk believe that

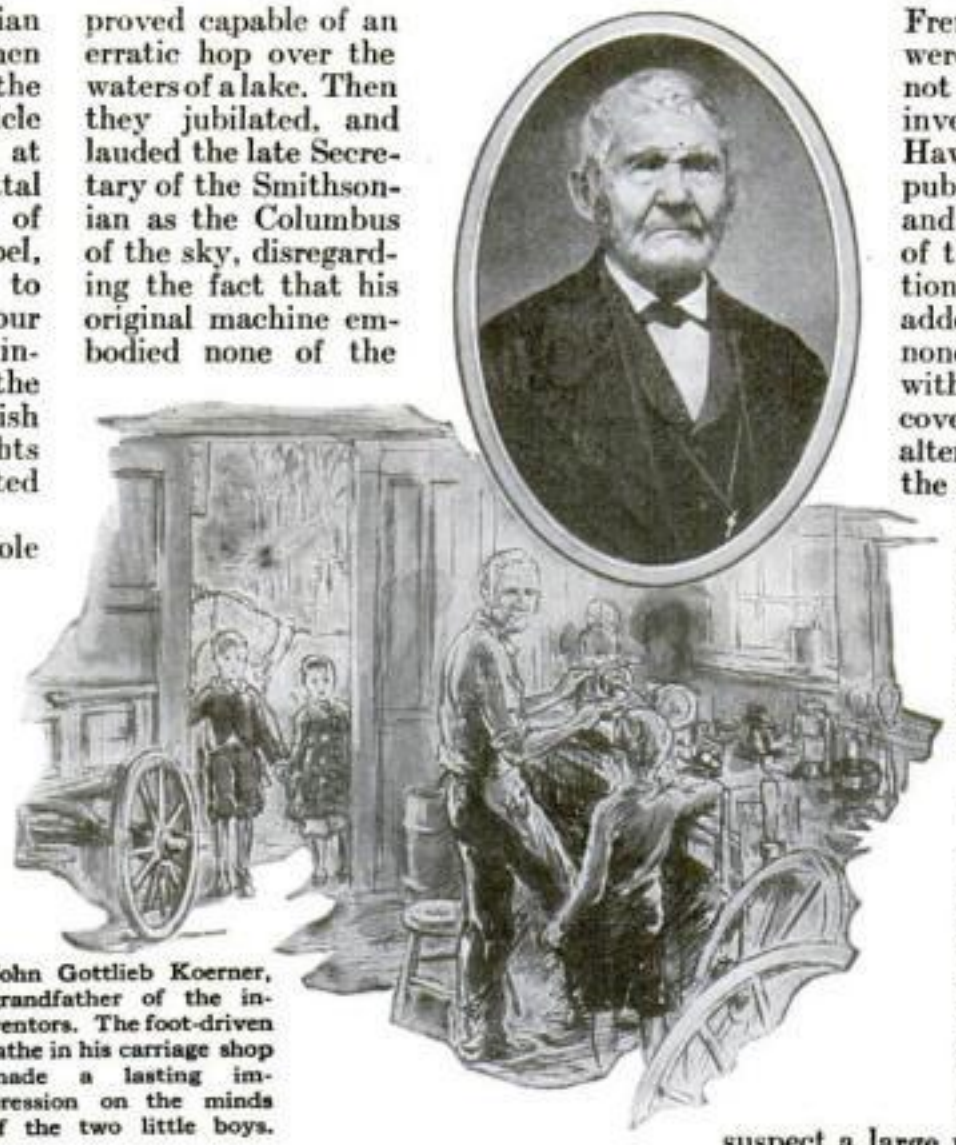
Professor Langley of the Smithsonian Institution and a lot of clever Frenchmen collaborated to secure the conquest of the air. Langley's attempt at a flying vehicle is now on view in the Smithsonian at Washington, D. C., with a noncommittal label that credits it as the ancestor of aerial navigation. Because of that label, Orville Wright, last year, declined to exhibit the real pioneer machine in our national museum at Washington and instead sent it to the friendly exile of the Science Museum in London. The English have been more hospitable to the Wrights than their own people—as represented by officials.

The public sees a mystery in the whole affair. It asks:

"IF THE Wrights are the true inventors, why are their claims denied or whittled down by Government scientists? Why have clever Frenchmen and others obtained credence for partial paternity of Daedalus' dream-come-true? Why, especially, have the Wrights kept a relative silence for years instead of proclaiming their case from the housetops? Why have they not long ago taken the public into their confidence, told their whole story, laid all their cards upon the table for the impartial judgment of mankind?"

I will give some short answers to these questions, in advance of the full explanations that will appear in the course of this narrative. First, I believe Government scientists are as human as anybody and those of the Smithsonian were very human in seeking to bask in the fancied glory of a colleague, the ill-fated Langley whose machine crashed in the Potomac River a few days before the historic feat of the Wrights at Kitty Hawk.

The scientists were glumly quiet for eleven years until the day when the Langley device, repaired, altered and new-engined, was proved capable of an erratic hop over the waters of a lake. Then they jubilated, and lauded the late Secretary of the Smithsonian as the Columbus of the sky, disregarding the fact that his original machine embodied none of the principles essential to practical flight. The late Dr. Walcott, successor to Langley as head of the Smithsonian, was chiefly responsible, in my judgment, for the ghostly revival of a museum chimera. Doubtless he was sincere in the belief that an eminent scientist, his friend and colleague, had to be right as against a pair of young "bicycle men" of Dayton, Ohio, who never looked inside a college door. Today the Smithsonian has a fair-minded and conciliatory head—but the Langley legend and tradition are hard to put down at the national capital.



John Gottlieb Koerner, grandfather of the inventors. The foot-driven lathe in his carriage shop made a lasting impression on the minds of the two little boys.

Prof. Langley does deserve our respectful homage in passing, for he attempted what was said to be impossible; and though he failed, his faith stimulated others to success.

What of the clever Frenchmen and others? They were all clever adapters, if not outright filchers, of the invention proved at Kitty Hawk. They were good at publicity and colorful feats and at commercializing. Some of them made real contributions to aviation and they added useful refinements, but none was able to dispense with the basic principles discovered by the Wrights or to alter the chief features of the original sky craft. There may be loopholes in patents, but not in the laws of Nature that govern flight.

Why have the Wrights kept a relative silence and endured a partial eclipse?

THEY were shy by nature and up-bringing, became reticent to protect an invention that many laughed at and tried to steal. They had no gift for publicity, shrank from clamor, feared and distrusted the prying press, came to suspect a large part of their fellow men. It was a natural reaction. They lived an inclosed home life with an aging father and an only sister. They never married. They had no knack for business. They received a small fraction of the proceeds of an invention which yielded millions to others and has a world value almost incalculable.

Wilbur, the elder brother, died in 1912. It was a great shock to Orville, who has striven since then to write a full account of an epochal achievement, as much to obtain complete honor and justice for that beloved brother's memory as for his own vindication. The task seems too much, it opens wounds, it involves the baring of family intimacies which to a super-sensitive character are inviolate.

I believe the American public has a right to view all the evidence that may

Orville Wright at the age of five—a regular boy. Making fires was an early passion. Once he started a blaze against a fence, but sister Katharine tattled. He still likes to see fire.

Above, the Wright brothers' sister Katharine, youngest of the family. She was destined to play a vital role in the dramatic creation of the airplane. At right: Wilbur at the age of five. Like his younger brother, he was shy and retiring.

help to unveil the mystery of the airplane origin and enable it to award due honor to the men of Dayton. Homely details are part of that evidence, often an essential part. The drapes of secrecy do not fit the captains and benefactors of mankind. It was my privilege to study the unpublished documents of the Wright brothers, their diaries, letters, and family records, as well as to talk at length with Orville, his father, and sister, while staying for several weeks at their home in the Ohio city. If the public had the same privilege, it would share my conviction that the Wrights stand amid the first scientist-discoverers of all time.

The Wright homestead in Dayton, O., where Orville was born and Wilbur died. This modest frame dwelling was largely the birthplace of the airplane. In the yard at left Wilbur sewed the wings for the pioneer aircraft.

I MET Orville Wright for the first time years ago in the lobby of a New York hotel. He was a small figure, neatly dressed, wearing a derby hat. One noted that his feet and hands were small. He limped a trifle in result of the one air crash of his career. His voice was low, his words pleasant but few, his manner oddly constrained. This man had borne the thunderous acclaim of multitudes in America and Europe, had been received by three kings, an emperor, and a president, yet in my inconsequential presence his eyes were cast down and his fingers twisted and twiddled a button on the front of his coat!

On our train trip to his mid-western home, Orville Wright thawed a bit in the Pullman smoking room—not because but in spite of tobacco, which he does not use. He chatted in his mild voice of the baseball score, weather, and farm crops. He began a long, quietly humorous tale of his brother Wilbur's scouting trip to Kitty Hawk, almost shipwrecked in a sailboat and saved from starvation by a glass of jelly that thoughtful Sister Katharine had packed in his bag. The inventor paused in his narrative and searched his memory.

"Let me see," he murmured. "Was it grape or currant jelly?"

He was bound to be exact in this detail as in every other part of the yarn. He chuckled a little as he happily recalled the kind of jelly that it was. Afterward I heard him discuss with his father the precise color of a cat that crossed the road in bygone time.

"Orville, it was a black cat," rumbled old Bishop Wright.

"NO, FATHER, I think it was gray with some white streaks."

With such a passion for the exact shades of truth in cats, jelly, and else (scientific, after all, and some important events in the Wright chronicle are dated by like seeming triviality), one may understand delay in the production of the airplane history by the surviving brother. The flying machine was created in four years, but twenty-one years have been too short to narrate its origin.

The guest in the fine new mansion on a hill overlooking Dayton was installed in the host's own room-with bath at the front of the house. Moreover, he was never permitted to follow or walk with the host through any doorway, but had to precede. Such old world or Southern courtesy almost caused the visitor in his turn to fiddle with his coat button!

IN CONTRAST to the stately, withal genuine, politeness of Orville was the cheerful sociability of Katharine and the amiable gruffness of the old Bishop. The household consisted only of this trio with "faithful Carrie" and husband to do all the work—servants treated as friends. There was about one visitor in a week, nor did the Wrights go forth more frequently on errands social or recreative.

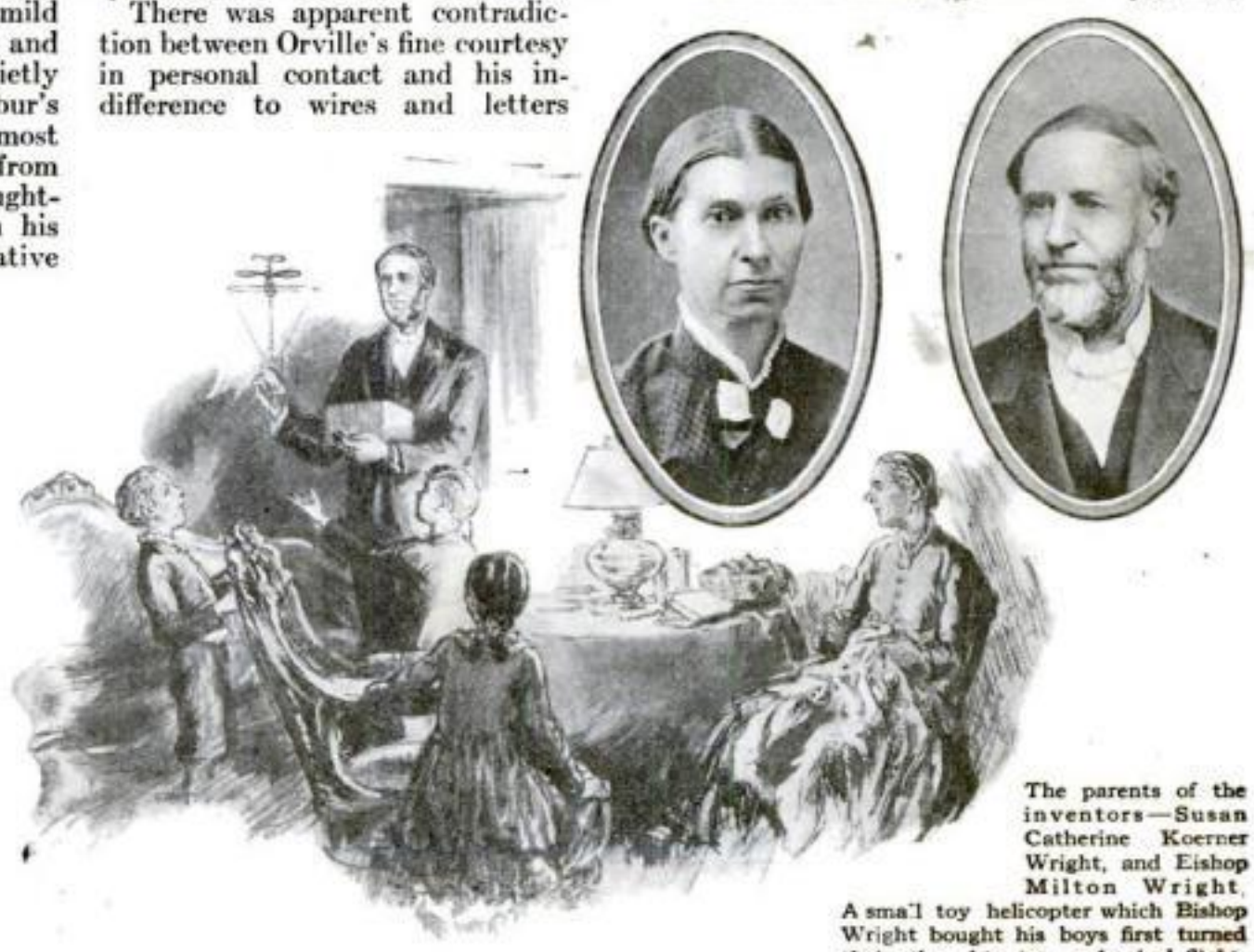
There was apparent contradiction between Orville's fine courtesy in personal contact and his indifference to wires and letters from the outside world. Editors and writers vainly coaxed him for statements: "reply collect" was no inducement. Perhaps he held the theory that time answers everything or that silence is a good reply. His sister would be delegated to respond to a few missives from those considered to stand within the circle of friendship.

HE DROVE to his city office daily in his own small roadster.

"I never have trouble with my car," he explained one day, "because I never do anything to it. Tinkering a car makes trouble. It is fixed right at the factory in the first place. Better leave it alone. I only give mine gas and oil. It does not use water."

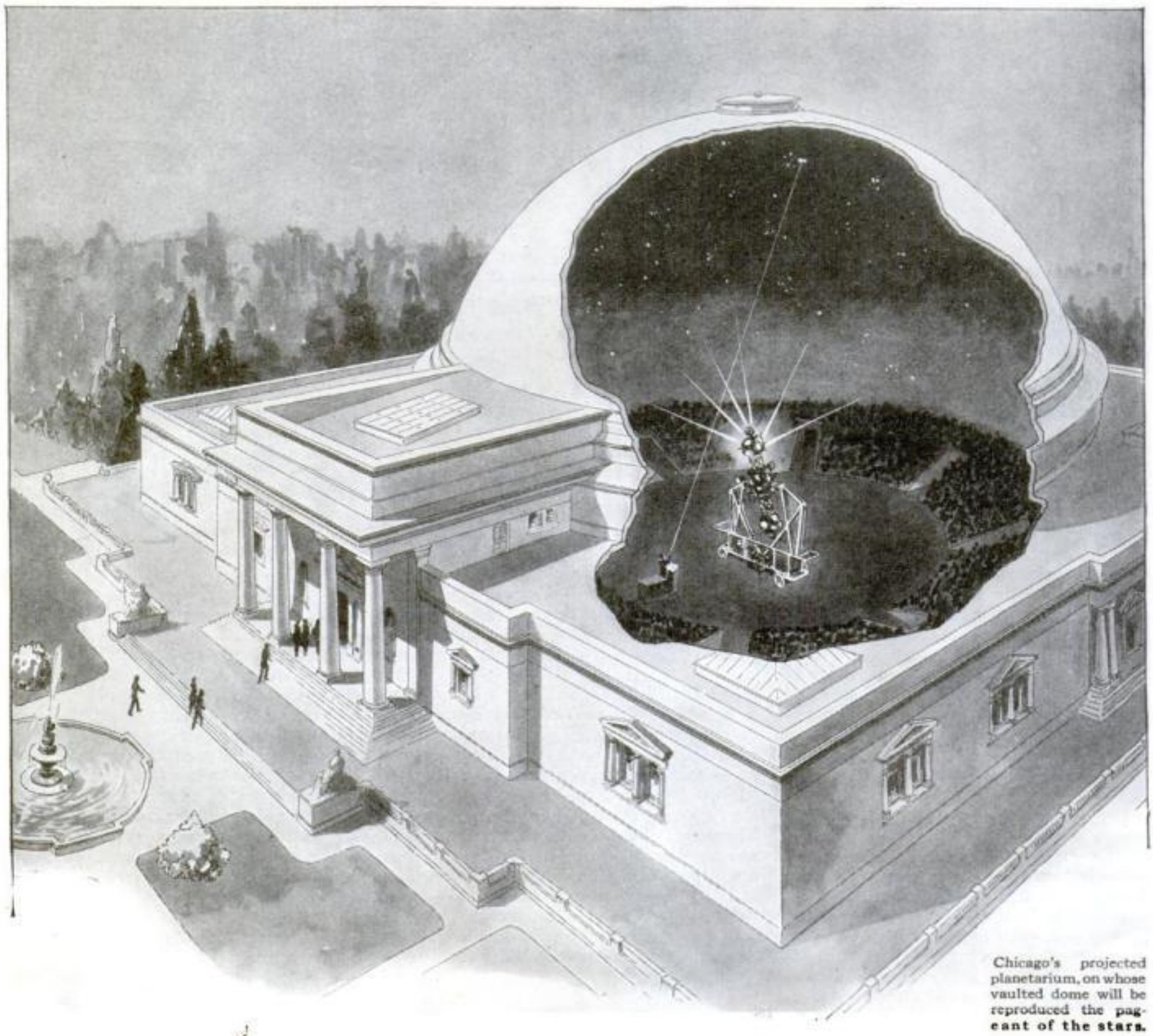
Some time later a home typewriter balked at its task of copying letters and documents pertaining to the birth of the airplane. Orville, forgetting his admonition on cars, essayed to tinker the wayward machine. He toiled at it with screw driver and pliers for three quarters of an hour. He examined, explored, poked, and pushed with serious intensity. Then he gave it up as a hopeless case. I laughed at the thought of the world's premier mechanic thwarted by a pesky little no-account device which a youthful repair man was able to adjust in five minutes.

At his office workshop Orville was then working, alone, on an automatic stabilizer for aircraft. It was a small but complicated affair with pendulum, mercury in gravity flow, and electrical actuation. On a later visit to Dayton I found the inventor just as interested in a scheme to drive a boat with an air propeller—he was fixing it up for a vacation trip in Canada with his favorite nephew, Buster, and thought it would be fun. At his home he also showed me with some pride how he had rigged up furnace regulator chains through the floor of the living room, saving a walk to the cellar. (*Continued on page 142*)



The parents of the inventors—Susan Catherine Koerner Wright, and Bishop Milton Wright. A small toy helicopter which Bishop Wright bought his boys first turned their thoughts to mechanical flight.

Half a Billion New Stars!



Chicago's projected planetarium, on whose vaulted dome will be reproduced the pageant of the stars.

Greatest Telescope, to Enlarge the Universe Eight Times, and Marvelous "Sky-Theater" Promise Untold Thrills in Astronomy

By EDWIN W. TEALE

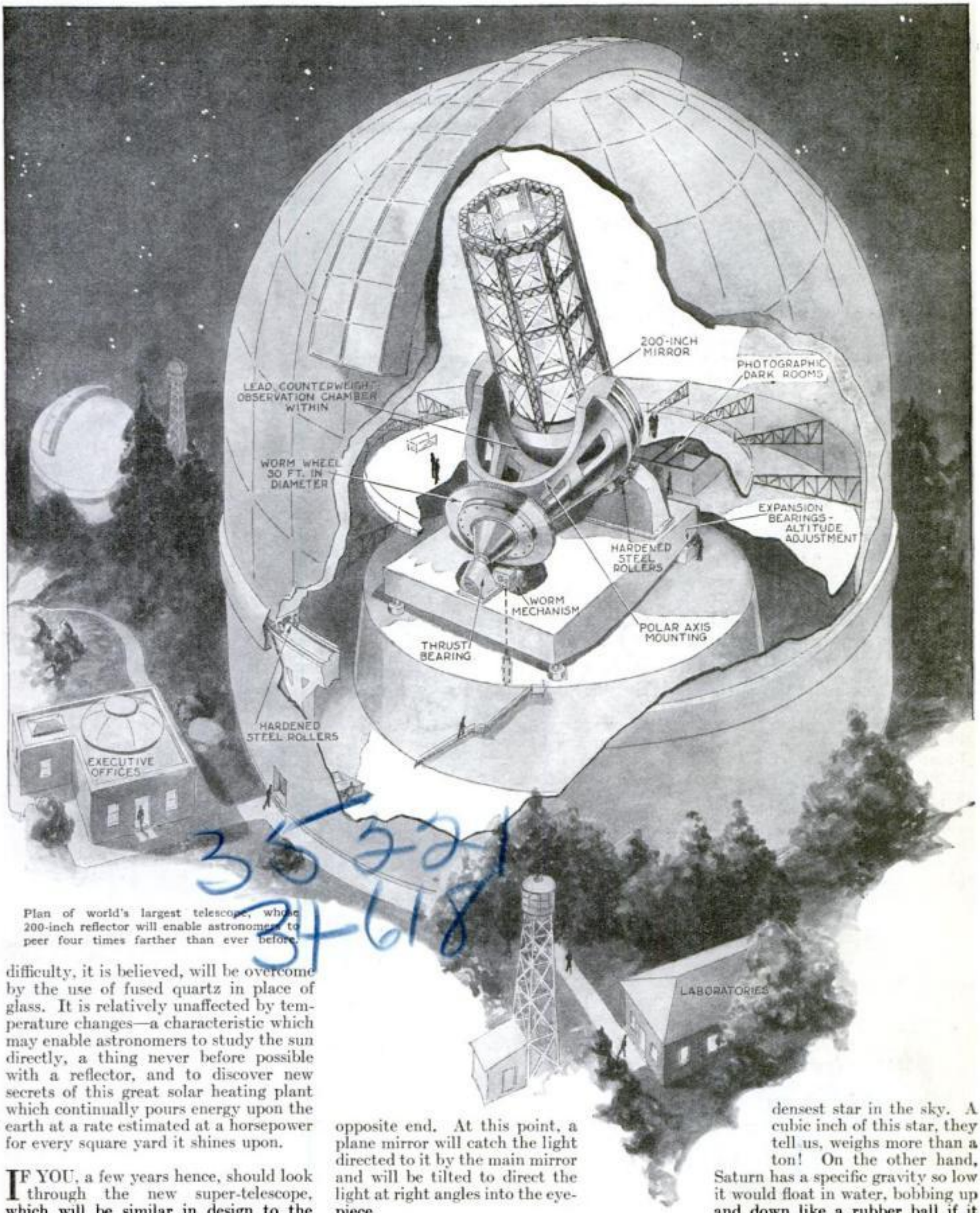
ON A California mountain top, a few years hence, there will take place one of the great adventures of all time. A man will look into the night sky and his gaze will penetrate beyond the most distant stars within the range of ordinary telescopes, past the lonely "island universes" revealed by the giant 100-inch Hooker instrument at Mt. Wilson Observatory, beyond the last confines of man's knowledge of the heavens, at least *four times* farther than any man has ever seen before!

This has just been made possible by a gift of the International Education Board to the California Institute of Technology, at Pasadena, for the purpose of building a 200-inch reflector telescope, twice the size of the largest now in existence. This monster eye is expected to multiply many times the sphere of our observation of the heavens and may show us half a billion nameless stars that lie outside the range of our best modern telescopes.

The delicate work of casting the fused-quartz disk for the great mirror, nearly seventeen feet across, will begin within a few months and the finished instrument is expected to be in use within three years. The magnitude of this undertaking can be appreciated when we are told that this mirror disk alone will weigh thirty tons—as much as fifteen good sized automobiles!

Heretofore the chief disadvantage of the reflector type telescope has been its sensitiveness to changing temperatures. Even a slight change in the room temperature is sufficient to expand or contract the glass of the Mt. Wilson giant the infinitesimal fraction of an inch sufficient to distort the image of a heavenly body under observation.

In the proposed super-telescope, this



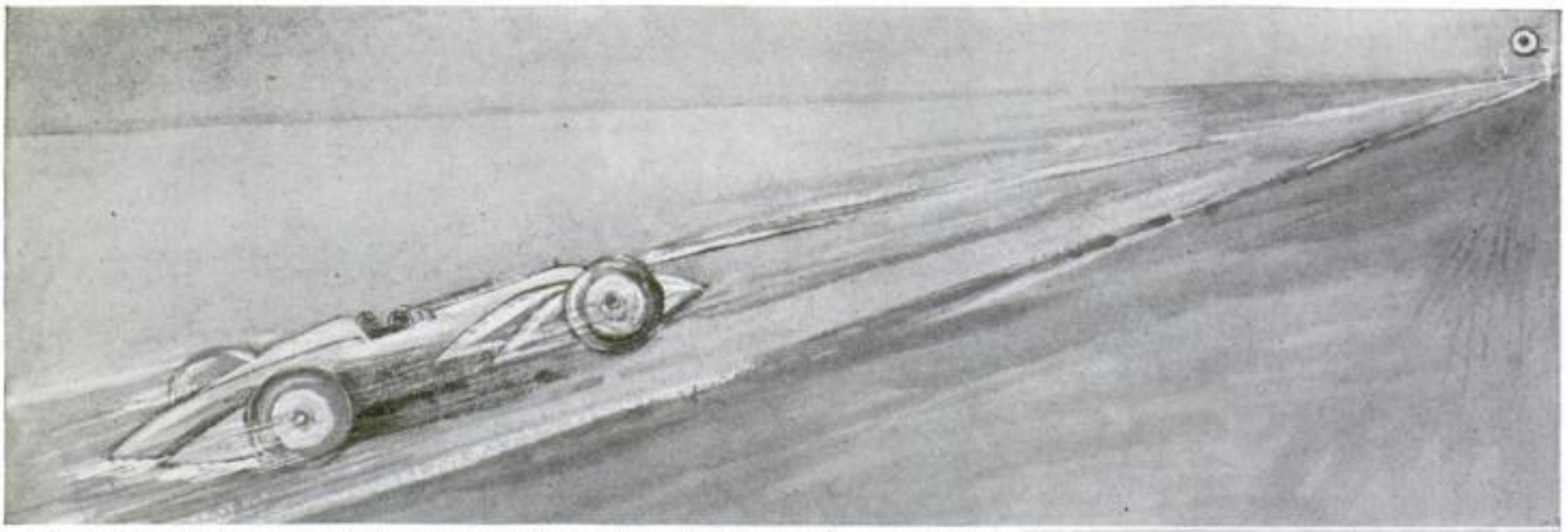
Plan of world's largest telescope, whose 200-inch reflector will enable astronomers to peer four times farther than ever before.

difficulty, it is believed, will be overcome by the use of fused quartz in place of glass. It is relatively unaffected by temperature changes—a characteristic which may enable astronomers to study the sun directly, a thing never before possible with a reflector, and to discover new secrets of this great solar heating plant which continually pours energy upon the earth at a rate estimated at a horsepower for every square yard it shines upon.

IF YOU, a few years hence, should look through the new super-telescope, which will be similar in design to the Hooker instrument, the first thing that would surprise you probably would be the position of the eyepiece. Instead of being at the end, as in the familiar "spyglass," it will be at the side. To see a star, you would look at right angles to the cylinder of the instrument trained on the heavens. The huge, dish-shaped mirror will be situated at the lower end of the cylinder. It will catch rays of light from a distant star and concentrate them at a point near the opposite end. At this point, a plane mirror will catch the light directed to it by the main mirror and will be tilted to direct the light at right angles into the eyepiece.

What the penetrating eye of the monster telescope will discover can only be conjectured. Mysteries are locked in almost every glittering pin point of light that marks the position of a star on a winter night. Take that unassuming little star that trails along behind Sirius, the brightest star in our heavens. It seemed to offer little interest until recently astronomers, with their sensitive instruments, weighed it and discovered that it is the densest star in the sky. A cubic inch of this star, they tell us, weighs more than a ton! On the other hand, Saturn has a specific gravity so low it would float in water, bobbing up and down like a rubber ball if it fell into an ocean large enough to contain it!

In one spot in the sky, so small to our eyes that it would not make a visible speck on the face of the moon, a cluster, in the constellation Hercules, contains more stars than are visible to the naked eye in both the northern and southern hemispheres! Opposed to this is "the darkest place in the sky," a black, pear-shaped spot (*Continued on page 129*)



Sheathed in a two-ton, streamlined projectile on wheels, aimed at a target a mile away, Major Segrave hopes to drive his "golden bullet" down Daytona's beach at a speed of four miles a minute!

Shoots His Racing Car at a Target

By MARCEL WALLENSTEIN

WITHIN a few weeks Major H. O. D. Segrave, of Great Britain, former champion in the lists for international speed supremacy, will fire his great golden car at a target on the sands of Daytona Beach, Florida, in a do-or-die effort to regain the motor car speed record for himself and his country.

Sheathed in a yellow metal cartridge, with 900 horsepower under the hood, Segrave hopes to cover the flying mile at a speed of 240 miles an hour! Double the speed of the average commercial airplane! Four miles a minute!

The best motor brains in England have combined to make the 1929 attempt such an overwhelming success that it will be almost a superhuman feat to overcome it as the last British speed records were overthrown by American drivers. There is no doubt that Segrave was vastly disappointed when, after driving his thousand-horsepowered *Sunbeam* at 203.79 miles an hour on the Daytona sands, his speed was exceeded by a fellow countryman, Captain Malcolm Campbell, in the *Bluebird*, which covered the flying mile over the same course at 206.96 miles an hour.

The entire British public was as greatly chagrined when Campbell's record was torn down by an American. After his record was broken, Captain Campbell repeatedly made preparations for another attempt. He searched the Danish coast, in vain, for a stretch of sand capable of affording as good a track as Daytona. He next announced he would make his attempt in the Mesopotamian desert, but this plan had to be abandoned.

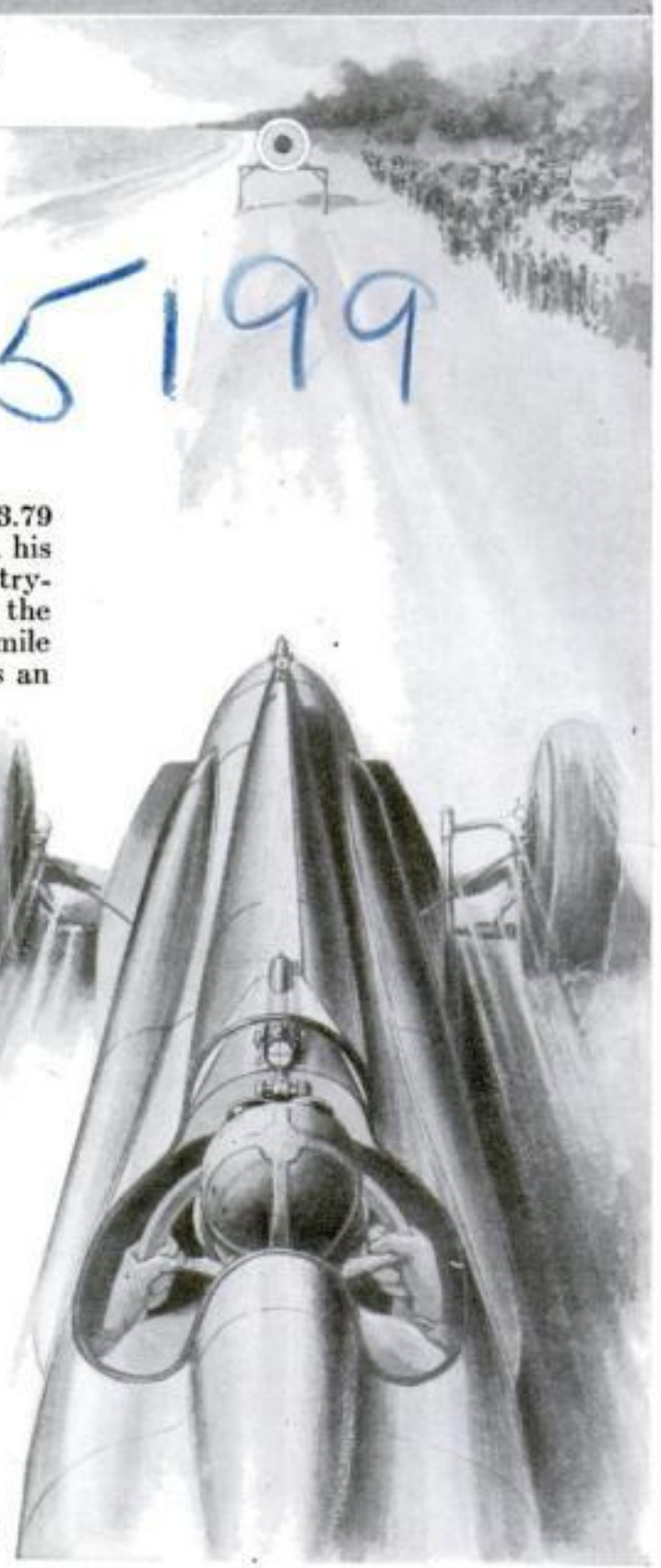
Meanwhile two London sportsmen offered to back Segrave in a second attempt at Daytona. The success of the British Supermarine seaplane *S-5* in capturing the Schneider Cup at Venice last year suggested the type for Segrave's new car.

The two principal problems of speed on the ground are wind resistance and tire strength. It had been proved that Napier could build an engine that would drive a vehicle at more than 300 miles an hour. It remained to provide the vehicle that would carry it against terrific wind pressure; and, also, pneumatic tires strong enough to hold it on its road-burning course.

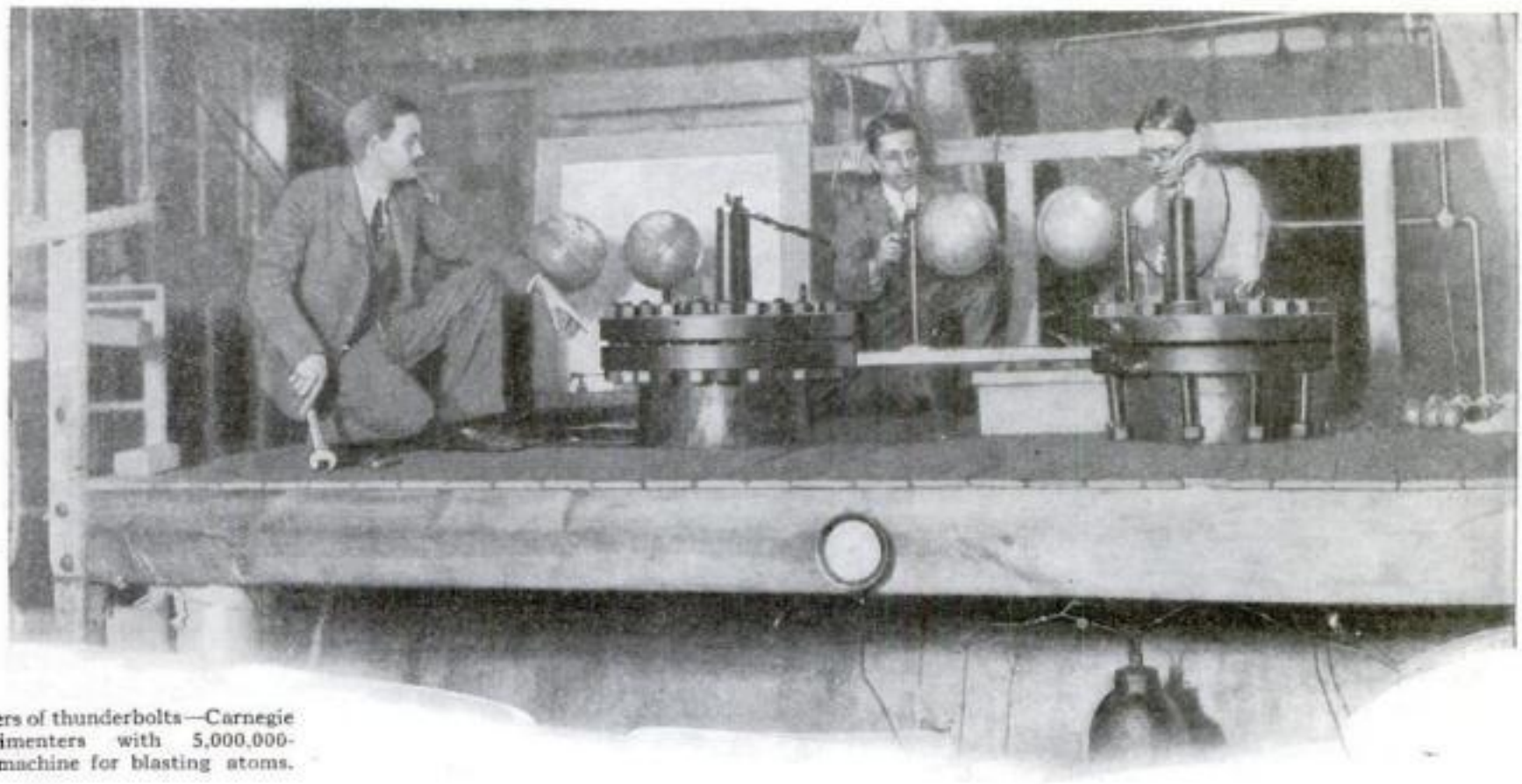
The matter of the car's construction was given over to J. S. Irving, the London motor engineer who turned out Segrave's 1,000-horsepower *Sunbeam*. With six draftsmen assisting, and detectives actually guarding their labors, Irving developed the *Golden Bullet*, as Segrave probably will christen his car.

Irving went straight to the Supermarine seaplane *S-5* for his ideas. If the victorious aircraft was correctly designed to win the blue ribbon of the air, why not the same (*Continued on page 152*)

Maj. H. O. D. Segrave, former speed king who seeks to regain his crown in the new car



Like a hunter's rifle, the car's hood is fitted with sights which Major Segrave will aim at the bull's-eye of the huge target.



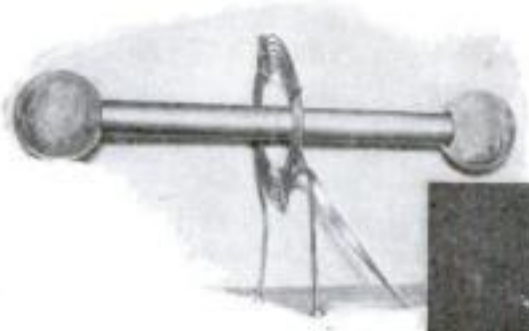
Tamers of thunderbolts—Carnegie experimenters with 5,000,000-volt machine for blasting atoms.

A Five-Million-Volt Gun Built to Smash Atoms

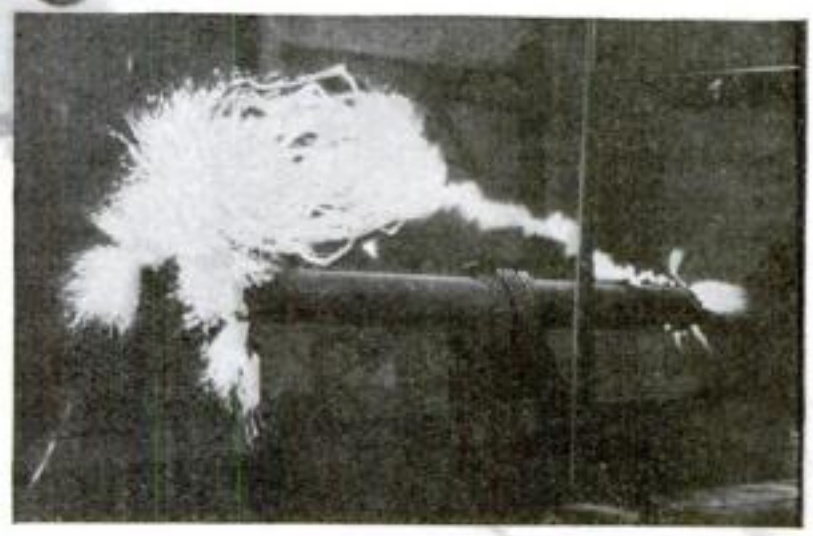
THIS is a story of modern alchemists—of bold experimenters who have dared to imprison stupendous forces. Wielding 5,000,000 volts of electricity, they seek to blast the building blocks of the universe and fulfill the long-sought dream of "transmuting the elements." A thrilling adventure that will end—no one knows where!

By

ALDEN P. ARMAGNAC



Above: Tesla coil of the type used in generating the high voltages. The knobbed bar, of heat-resisting glass, is wound with 8,000 turns of silk-covered copper wire.



Right: Tremendous energy released in a magnificent display. Here is the Tesla coil sparking at about 300,000 volts, sending flashes of man-made lightning.

BLINDING streaks of flame sear the laboratory air. A crackle and sputter like a red-hot boiler dropped in a water tank. Forked lightning writhes, twists, darts from two great balls atop a ten-foot metal cylinder. Five million volts are on a rampage—the most stupendous force ever wielded by the hand of man!

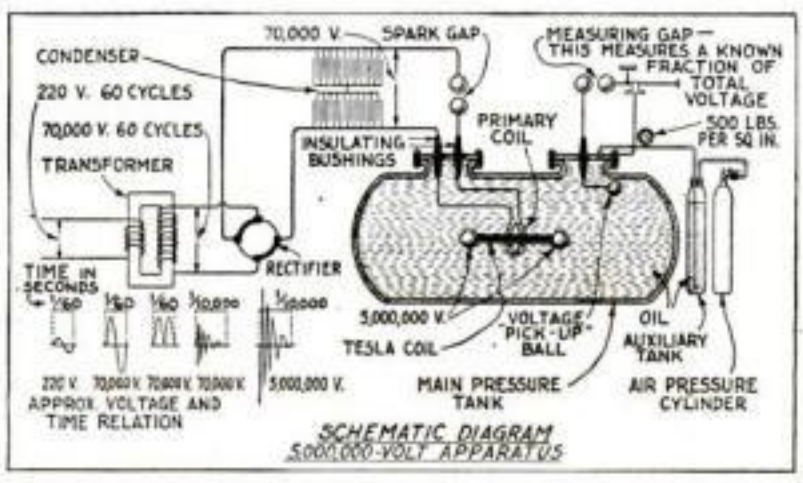
The occasion is the trying out at the Carnegie Institution's laboratory, in Washington, D. C., of a monster electric machine designed and recently completed by Dr. G. Breit and Dr. A. M. Tuve. Its purpose is to manufacture electricity—artificial lightning—of a greater voltage than has ever been generated before in a laboratory. By doing so, it paves the way for researches that may have startling and revolutionary consequences.

When the apparatus is operated, visitors stand at a distance and, though it is broad daylight, watch the room shot fitfully with the dazzling unreal brilliance of a thousand arc lights. They are witnessing human beings out-Joveing the mythical master of the thunderbolts himself. Here is lightning tamed; caged, for men to play with. This 5,000,000-volt machine the Carnegie Institution scientists have built to tear apart the innermost particles of familiar substances like iron and gold. With its stupendous power they are to attempt a feat abandoned as impossible 500 years earlier and only lately readmitted to scientific consideration—the transmutation of the elements, the changing, say, of such supposedly immutable things as silver and lead into gold and iron.

Until Sir Ernest Rutherford, in England, began bombarding atoms with radium a few years ago, the most powerful forces that science could bring to bear had failed utterly to dent their internal structure. The electric furnace's terrific heat, blinding discharges of electricity as powerful as were then available, chemical explosions, and the inconceivable cold of liquid air, were tried in vain. It was Rutherford who conceived the brilliant plan of using the flying particles that speed like bullets from a grain of radium to knock atoms to pieces.

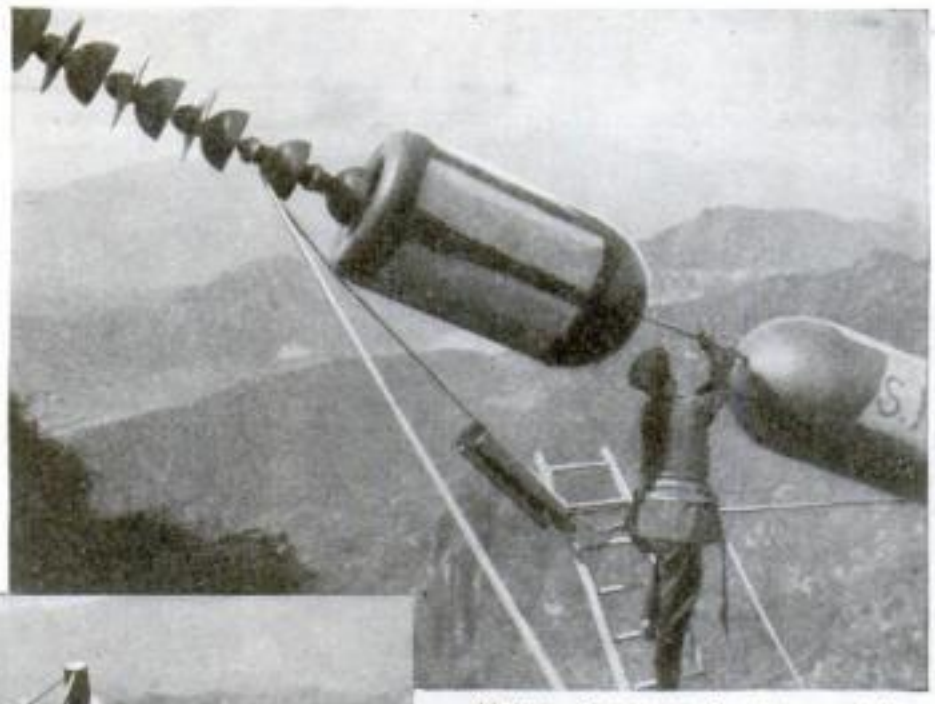
And, at least on a laboratory scale, he succeeded! He was the first modern alchemist, for he actually turned small quantities of aluminum, phosphorous, and other supposedly unchangeable elements into hydrogen.

Modern scientists believe that



Showing design of the 5,000,000-volt apparatus at top of page.

the atoms of every element in our list of the ninety-odd substances from which all things are made are built of two different kinds of particles called "protons" and "electrons." An atom of hydrogen, lightest known element, has one of each. Helium, the next heavier, boasts four apiece, and so on. Thus modern science has arrived at the remarkable conclusion that what a substance will be depends solely upon how many protons and electrons, or electrified particles, its atom contains—in plain English, how heavy it is.



Above: Enormous insulators of the 2,500-foot aerial erected by German experimenters in the Swiss Alps to capture Nature's lightning and turn it to the atom's destruction. Left: Two million volts flashing in a 13-foot spark during a thunderstorm.

SUPPOSE we could give an atom of iron, say, a "reducing treatment" and knock off, not a few pounds, but a weight so small that we can count it only in protons and electrons. The new atom won't be iron any more! It may be manganese, chromium, vanadium — or almost any lighter element, depending on where the reducing treatment stops.

Nor do the possibilities stop there. Perhaps if we could command suitable forces, we could make atoms "put on weight," too—build them up into heavier substances, as silver to gold.

When the Carnegie experts began the construction of their giant apparatus, there were only a few high-voltage electric laboratories in existence. At the General Electric Company's laboratories in Pittsfield, Mass., crackling artificial lightning of 3,600,000 volts had been produced. The California Institute of Technology has an outfit with a capacity of a million and a half volts, and Stanford University has a test set that can boast a million. Two or three installations in Europe are of equal capacity.

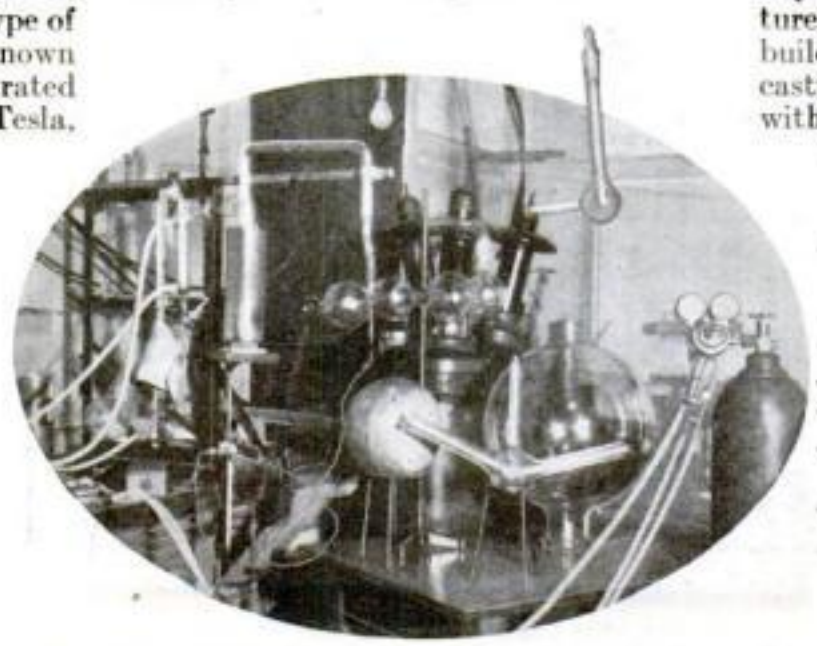
BUT Dr. Breit and Dr. Tuve, the Carnegie experts, decided to build a transformer that would step up ordinary electric current to hitherto unconceived voltages. For design they chose a type of high-frequency transformer widely known as the Tesla coil—a device demonstrated almost forty years ago by Nikola Tesla, whose remarkable electrical inventions were recently described in this magazine. Coils of this type in every high school today amaze the uninitiated by flaming sparks of thousands of volts, as much as a foot long, which, however, because of their rapid vibrations, pass harmlessly through a person's body.

The Carnegie experimenters built such a coil—a curious three-foot long, three-inch thick, knobbed bar of heat-resisting glass, wound with 8,000 turns of silk-wound copper wire, surrounded by a small spiral of copper tubing. When a great condenser, or storage jar, filled with electricity at thousands of volts from a high voltage transformer and a rectifier—the power supply of an ordinary X-ray tube—was discharged through this spiral, a miniature bolt of lightning surged through the tight-wound copper wire. Great sparks and streamers, and electrical leakage over all parts of the coil, kept the measured voltage from rising above 300,000 or 400,000 volts. That was not high enough.

They immersed the dumb-bell shaped Tesla coil in a great tank filled with oil. And at once the leakage ceased. Up to three million volts rose the pressure in the coil before sparks from the caps on the ends of the coil would flash out into the oil.

Then they played their trump card. They closed the tank, attached a pump, and proceeded to compress the oil to the terrific pressure of 500 pounds to the square inch. Stand the Woolworth Building in the ocean right side up, with its tower just at the water's surface, and the sea pressure at the ground floor would still be less than that in the tank.

Then two metal balls atop the right-hand end of the tank, which by the length of the spark that leaps between them measure a known fraction of the total voltage, burst into electric flame. They were registering a current of more than 5,000,000 volts!



Apparatus developed at the Carnegie Institution in the search for a vacuum tube capable of applying 5,000,000 volts to the atom. So far 1,000,000 volts is the greatest a tube can stand.

"BY SLIGHT changes in the design of the coil," Dr. Tuve says, "even higher voltages can be obtained when they are desired." So far the highest of all has been 5,200,000.

This colossal voltage the Carnegie experts are preparing to launch upon atoms of familiar substances, to see what will happen. It remains only to perfect a vacuum tube—figuratively, the muzzle of this giant siege gun—capable of applying it. Though no tube to date has been devised that will resist puncture or short circuit by such a tremendous lightning bolt, the invention of one seems near.

"We have been able to operate one of our tubes at more than 1,000,000 volts for a short time," Dr. Tuve says. Dr. Coolidge, of the General Electric Company, he adds, has perfected a "cathode ray" tube that works at 900,000 volts and will probably go higher. Within the last few months Drs. Lauritzen and Bennett, of the California Institute of Technology, have made one which has operated several times at a million volts; and so the quest continues, with promise of success just around the corner.

WHAT will it mean to science and industry when, through such tubes, five million volts or more is turned loose? The scientists' concern, of course, is to see what will happen to familiar substances, placed within these vacuum tubes—whether they will turn into new substances before their eyes. But several other things may happen, of tremendous practical consequences.

For example, such tubes would produce X-rays more intensely penetrating than any ever before imagined. X-ray pictures could be taken through a whole building. Others could show flaws in castings many feet thick, as compared with the present effective range of only a few inches. Not alone in industry, but in the science of medicine and health the new super-voltage tubes might have supreme importance. The effect of such high voltage applied to a human being is utterly impossible to predict.

Nor are the Carnegie Institution experts the only ones engaged in the quest. In a little steel-sheathed lightning-proof cabin near the summit of Mt. Generoso, a 6,000-foot peak near Lugano, in the Swiss Alps, three bold Germans are making ready one of the most daring experiments in the history of mankind. They pro-

(Continued on page 148)

The Tallest by Fifteen Stories

CONSTRUCTION soon will begin on what will be the world's largest and tallest building—the Chicago Tower and Apparel Manufacturers' Mart. Seventy-five stories high and covering two city blocks, it will house in addition to offices and stores, a 440-room hotel, a 1,024-car garage, two clubs, a hospital, swimming pools, gymnasiums, and even a small golf course.

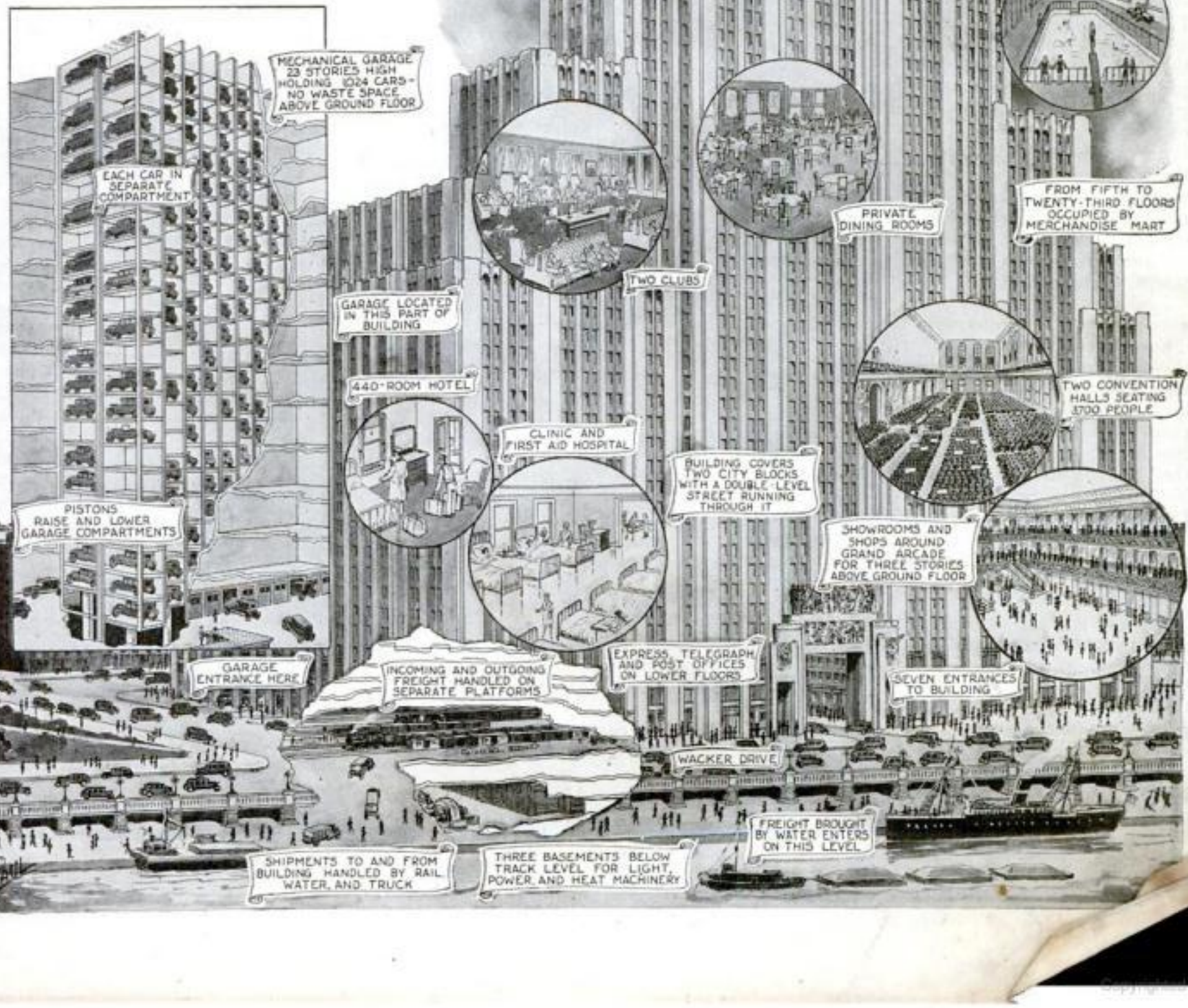
A railroad is to run through the basement, trucks can drive in from the streets, and vessels from the Great Lakes will steam into the Chicago River and discharge cargoes in front of the building.

The total cost of the building, which would tower fifteen stories above the Woolworth Building in New York City, will be about $45,000,000.

One of the most interesting features is a mechanical garage where workers will park their cars. The drawing below shows how each automobile fits into an individual compartment.

These compartments rest upon one another in shafts, in which they are raised and lowered by pistons.

Our artist pictures here the remarkable features which will be embodied in the world's greatest building when completed in Chicago.



Armored Ships Win Thrilling Battles with Polar Ice

Flirting Daily with Death, They Smash through Frozen Barriers to Vanquish the Earth's Farthest Strongholds

By ROBERT E. MARTIN

IF YOU have ever known the thrill of adventure, the battle against odds in the uncharted places of the world, you'll find this article of absorbing interest. No fiction can compare in moving incident with this modern saga of the great white North. It is a story of heroes who risk all to conquer the frozen seas.

SOMEWHERE in the South Pacific, Commander Richard E. Byrd and his party of fifty-five adventurous men have finished the first lap of their two-year Antarctic expedition aboard the ice-breaking whaler *C. A. Larsen*, largest ship of its kind in the world.

To this hulking, awkward-looking giant, battered and torn but never conquered in a hundred battles with the frozen seas, the explorers entrusted their lives, their precious equipment, and their high hopes for success when they started out from Los Angeles last autumn.

Commander Byrd chose the *C. A. Larsen* for his expedition because of its powerful build and its record as an ice-fighter. The type of vessel familiar to the average ocean traveler would be of no more use in making a voyage through eternal ice than a perambulator would be in an attempt to cross a desert.

Just a few days before the departure of the Byrd expedition, first reports reached this country of the stirring adventures of the Russian ice-breaker *Malygin*, which penetrated the icy wastes of the Far North last summer with its sister-ship, the *Krassin*, to rescue General Umberto Nobile and his crew of the airship *Italia*. Later it pursued a vain search for Roald Amundsen, the Norwegian polar explorer, who lost his life attempting to save those of the Italians.

Breaking ship lanes through the ice-locked port of Helsingfors, Finland. Right: The Russian ice-breaker *Krassin*, famed for its heroic part in rescuing the crew of the lost dirigible *Italia*.

ABOUT the same time, too, the U. S. Coast Guard patrol boat *Marion* returned from a two-months' expedition to the waters between Labrador and Greenland, during which an oceanographic survey yielded a wealth of important findings, among them the fact that the Arctic climate, temporarily at least, is getting milder and may continue to lose some of its rigors.

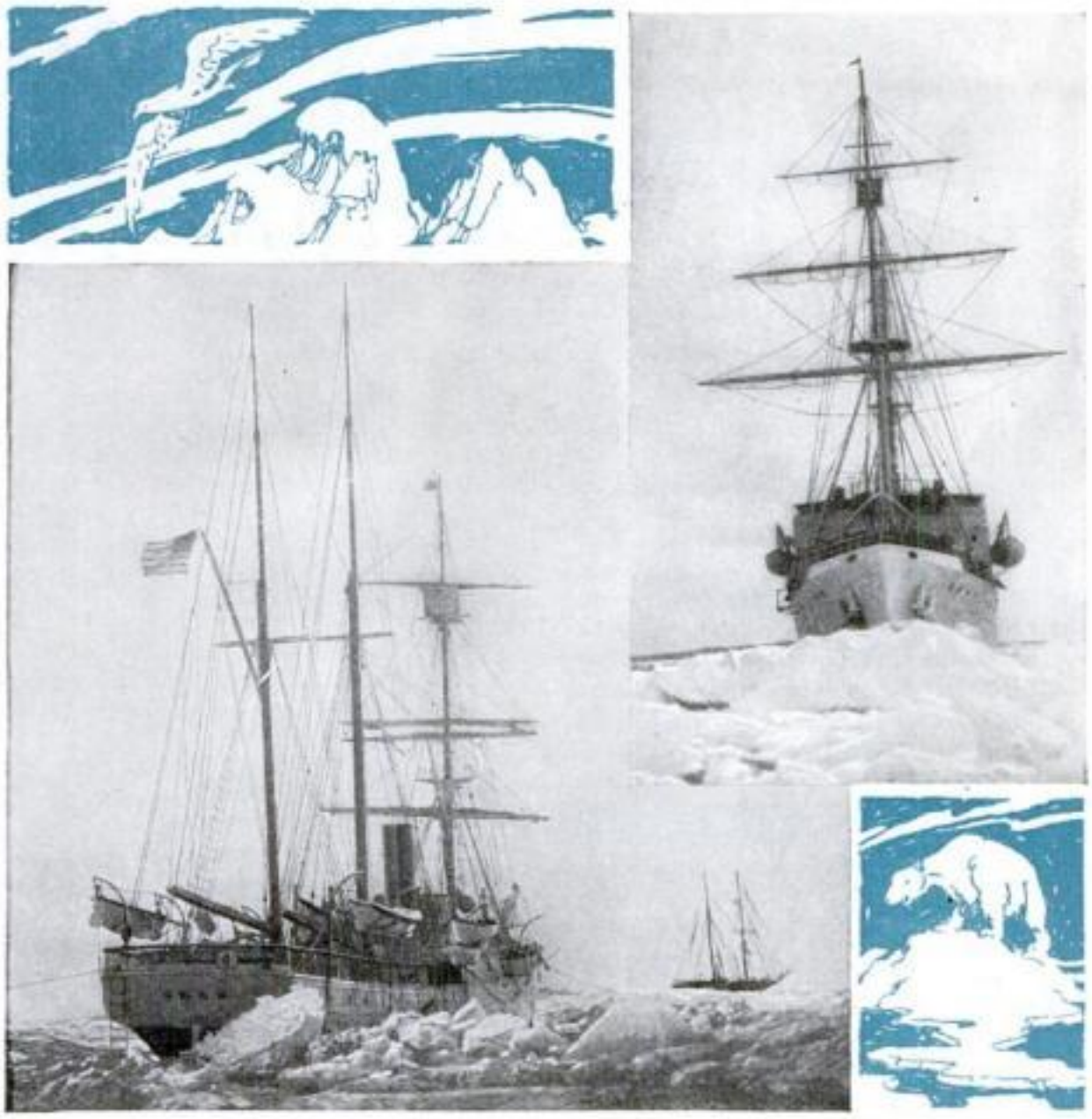
All these events served to focus attention on the obscure but heroic part played in scientific exploration, navigation, and commerce by the sturdy pathmakers through frozen waters. Without the ice-breaker, expeditions such as that of Commander Byrd would be impossible; Nobile and his men would have perished; the Poles never would have been discovered, and the year's season of navigation, as well as the extent of shipping routes, would be considerably curtailed.

The United States has ice-breakers in service on the Great Lakes, along the coasts, and on inland waterways to keep the lanes of navigation open. The cutters of the Coast Guard ply the North Atlantic, where they locate icebergs and warn mariners of the movements of these floating mountains. Every so often, as in the recent case of the *Marion*, they are used for study and survey.

Through its rescue of Nobile and his men, the *Krassin*, a Russian ice-cutter, won world-wide fame overnight. But the name of its sister steamer was not even known until the story of the *Malygin's* hardships was brought to America through the Soviet Union Information Bureau in Washington, D. C. Then it transpired that this valiant vessel, too, covered itself with glory on a trip filled with perils and thrills.

WHILE most of us, in sweltering heat, were preparing for Fourth of July celebrations, the *Malygin* was ice-bound several times and went through two terrific storms, during one of which it narrowly escaped shipwreck on Hope Island, a rock island in the Arctic never before visited. Time and again the bewildering fog of the Far North threatened to engulf the ship and its crew.

With a Junkers plane and pilot, M. Babushkin, aboard, the *Malygin* set out on its rescue mission from Archangel. When it returned to port, the boat was battered almost beyond recognition, and the aviator had made fifteen flights over



Uncle Sam's ice-fighters, old and new. The larger picture shows the veteran wooden Coast Guard cutter *Bear*, which for thirty-nine years served as policeman, hospital, and food supply base in Alaskan waters. She is succeeded by the steel cutter *Northland*, seen in top picture.

the ice and once had been lost for five days. On each of his trips, Babushkin had to resort to the dangerous expedient of taking off from the ice and landing on it again. At one of his perilous hop-offs, the pilot had to shoot a polar bear that tried to climb one of his wings!

In the beginning, all went well enough. The *Malygin* pushed a path through a semisolid, semifrozen substance resembling porridge. But soon, as Captain Chertkov steered a steady northward course, huge floes appeared, rumbling against the ship's sides and hitting the timbers with thundering crashes.

Slowly the ice tightened its grip. Every now and then the *Malygin* stuck, backed water, and plunged with all its might against the floes. At such times, the whole ship shook and its beams groaned in protest. The men aboard began to wonder whether the boat would ever make Hope Island, its first objective, and to fear lest somewhere ahead of them the crew of the *Italia* might be dying.

Unable at last to smash through a wall of ice four and a half feet thick, the vessel came to a full stop.

It was midnight. The ship was thirty miles from the island. Three hours later another attempt was made to break through. By dint of herculean labor, the ice-breaker battered her way for seven miles in four hours!

WHEN the weather cleared a bit, Hope Island was sighted, a black granite mass. But the route to rescue lay beyond the island, around it and to the north. Foyn Island, where radio dispatches had reported the camp of the *Italia's* crew, was situated nearly ninety-four miles from King Charles Land, north of Hope Island.

For two days more the *Malygin* fought the imprisoning ice in vain. Then it was decided to send out the plane. Babushkin, accompanied by a mechanic, a hydrographer, and a radio operator, took off from a hastily constructed scaffolding. But fog suddenly swooped upon both ship and airplane. Babushkin, then thirty miles from King Charles Land, returned. Shortly after the aviators were back on board, a radio report was received telling that Amundsen was lost.

At midnight of the following day the plane took off again on what was expected to prove a six-hour flight. But fourteen hours of anxious waiting followed! In that time, fog twice completely enveloped the ship. Then the plane returned. The aviators were safe. They had reached King Charles Land and, after frightening off three polar bears, had cached gasoline cans and planted the red flag of the Soviet.

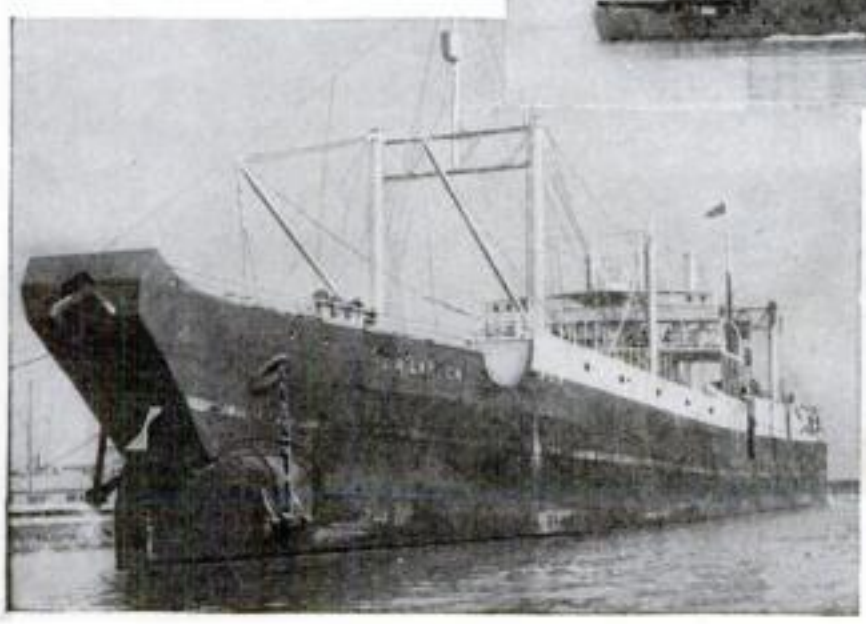
A couple of days later, motors having been overhauled, Babushkin started on a direct flight to Foyn Island. An hour after he took off, radio contact between the plane and the ice-breaker was broken.

DURING the five days that followed, when no word from the plane was received, the *Malygin*, jammed in by the ice, escaped shipwreck on Hope Island by what seemed a miracle. The ice-breaker lay helpless, motionless, waiting. Slowly countless tons of ice crowded closer. The wind howled in the rigging. Enormous floes, climbing higher and higher like monstrous white beasts, ground against the groaning ship. Inside, the *Malygin's* partitions began to crack.

And always the pitiless, blinding glare of endless Arctic snow under the midnight sun. A great ice field approached and splintered the hull. Another one, still heavier. The ship was tied up with huge hawsers to anchors of ice; made fast to a gigantic floe.

Meanwhile, the radio operator stuck to his post. Every ten minutes he sent the call, "*Malygin*, airplane, where are you?" No answer. He received a message from Moscow, "Seek Amundsen to

(Continued on page 154)



Left: The ice-breaking whaler *C. A. Larsen*, of Commander Byrd's Antarctic expedition, the largest ship of its kind. Top: U. S. Coast Guard patrol boat *Marion*, steaming past a Greenland glacier during recent Arctic survey. Above: Recording water temperature from the *Marion*.

What the World Owes to 1928

Leaders in Many Fields of Applied Science Tell of the Year's Most Valuable Contributions to Progress

AVIATION

ALEXANDER KLEMIN, Sc.M.
Professor of Aeronautics, New York University

IN AIRPLANE design, perhaps the most striking advance has been in the cruising speed of commercial planes, particularly of the transport type. Cruising speeds of 110 miles an hour were considered satisfactory two years ago. Now the operators demand 130 miles an hour. The advance is due mainly to refinement of streamline. The commercial airplane begins to look more and more like a racer.

In airplane safety, a significant step is increased experimentation with the leading edge slot, perhaps the greatest safeguard against the much dreaded spinning nose dive.

In the power plant, the outstanding event of the year is the flight test by the Packard Motor Company of an air-cooled radial Diesel engine, weighing only three pounds per horsepower. The greater economy of the Diesel means a far greater range for the airplane, and the use of heavy fuel in the Diesel is the greatest protection against fire.

Interest in the autogiro has been revived by its flight from London to Paris.

There has been a tremendous revival of interest in airships. Though the ocean crossing of the *Graf Zeppelin* was checkered, many authorities regard the airship as the only craft for trans-Atlantic travel.

It is gratifying to see the enormous extension of American Air transport.

COMMUNICATION

R. W. KING, PH.D.
Editor, Bell System Technical Journal

PERHAPS the most outstanding event of 1928 in the communications art was the joint meeting of some 1,000 engineers in New York and 500 electrical engineers in London, the trans-Atlantic telephone tying the two groups together almost as though they had been in one auditorium. During its second year, trans-Atlantic telephone traffic has grown rapidly and the first supplementary short-wave channel to carry the rising load was opened.

Developments of previous years are finding expression in the continued growth of the telephone cable network connecting important cities, about 2,000 miles having been constructed during the year. Carrier types of telephone and telegraph circuits are assuming great importance and during the year a new carrier telephone system designed for lines from fifty to 200 miles in length was widely installed.

In the entertainment field, the telephone companies have made new advances in the adaptation of circuits for tying broadcasting stations together. The new art of talking motion pictures, which bids fair to create as great popular interest as broadcasting did, uses acoustical apparatus that has arisen within the communication art. Scarcely less spectacular may finally be mentioned the sending of television images by sunlight.

ENGINEERING

BY F. W. PEEK, JR.
Consulting Engineer, General Electric Company

WHAT have been the most important advances in electricity and electrical engineering? To answer in a few words is difficult, so bound up with almost every phase of human activity has the subject become.

Among the accomplishments of electrical engineers in the past year must be included the remarkable advances which have brought much nearer the day of practical television, a joint meeting of electrical engineers in London and New York by radio telephone, the televox for automatically controlling electrical equipment, the application of vacuum tubes to many new fields, the development of the 900,000-volt cathode-ray tube, the solution of stability problems of long-distance high-voltage transmission, the 50,000,000-cycle tube with ten-kilowatt output, photo-electric tubes of greatly increased sensitivity, perfection of the radio beacon for guiding aviators, and the establishment of the study of lightning on a truly engineering basis.

Commercial installations of highly efficient hydrogen-cooled rotating equipment, generating stations designed for turbines using 1,200 pounds steam pressure, decided advances in electric welding, further fields invaded by electric heating, new speed and efficiency records by electric ships—these and many more advances must also be included.

PHOTOGRAPHY

C. E. K. MEES, D.Sc.
Director, Research Laboratory, Eastman Kodak Company

THE tendencies in photographic progress shown in 1927 have developed further during the past year.

Panchromatic film sensitive to all colors has almost displaced the old noncolor sensitive film for the production of theatrical motion pictures. Reversible panchromatic film for the amateur movie maker has also appeared on the market and is rapidly coming into favor.

In the field of standard motion picture production, by far the most important innovation is the introduction of sound records. These are at present made by several different methods and the procedure is by no means standardized, but it is evident that the recording of sound will play an important part in motion picture technique in the future.

The greatest sensation of the year was the announcement of a perfected process by which amateur cinematographers could make films in natural color instead of in monochrome. The process involves only the addition of color filters to the camera and projector and the employment of a special film. The results have been generally approved as of excellent quality. Difficulty of duplication and restriction of the size of image owing to loss of light by the absorption of the filters are confining the process to the amateur field for the present.

TRANSPORTATION

FRED W. SARGENT
President, Chicago and Northwestern Railway Company

IN THE year just past a pound of coal has been made to move a ton load of freight 7.74 miles, while in the previous year a pound of coal moved a ton 7.4 miles. That is a gain of about five per-

THE year 1928 passes into history. What was its importance to you and me? By what great discoveries, useful inventions, and gifts of knowledge will it best be remembered? We put these questions to recognized authorities in the various fields of science. We asked them to tell the readers of POPULAR SCIENCE MONTHLY briefly what, in their opinion, were the outstanding advances of the last twelve months. Their interesting answers, which appear on these pages, will aid you not only to keep in step with the front ranks of science, but to view with new understanding the prospects of still greater progress to come.

cent, seemingly insignificant on its face; yet it meant a saving of 3,800,000 tons of coal.

Railroads have made marked advances in utilizing modern and improved appliances. Automatic train control is coming into general use. Roller bearings on passenger cars are proving their worth. Cast steel tenders for locomotives, and cast steel trucks for cars, promise marked economies. Larger and better freight cars are becoming widely used. Many roads have been improving terminals and installing hump yards with electric automatic car retarders.

Elmer Sperry appears to have developed an electrical machine that will detect possible flaws in steel rails. And I think we have learned that we can lay rail seventy feet in length instead of thirty-nine feet, thus reducing the number of rail joints and otherwise providing a better and a smoother track.

Superheaters, syphons, back pressure steam gages, better boxes and grates, and larger power units have improved the steam locomotive. Gas-electric and Diesel cars have been introduced, largely on light branch line runs and may gradually supplant the steam locomotive for certain classes of terminal service; but for general heavy switch and road haul business the steam locomotive has yet no equal either in economy and efficiency.

RADIO

DAVID SARNOFF
Vice-President and General Manager, Radio Corporation of America

THE radio art in 1928 largely emerged from the period of discovery to the application of electrical and engineering principles already developed in the laboratory. Chief of these developments was the perfection of the A.C. tube.

The use of radio in the home has been reduced almost to the simplest terms. The new A.C. tube has stabilized the operation of the modern receiving set. A practically inexhaustible source of power has been made available for radio from the electric light socket. Problems of installation, operation, and maintenance have been simplified. Other refinements have been in the direction of unicontrolled tuning processes and better tonal qualities.

Further fundamental progress in radio must await the results of continued research into the wave channels of space. Our vision has been widened by the exploration thus far of short-wave channels. But there are many problems to solve. We have not yet plumbed the full possibilities of short-wave transmission.

Until research determines the best channels of transmission and experiment teaches us how best to utilize them, television, despite technical progress made, must remain primarily a laboratory development. Demonstrations made during the year, however, showed marked progress in the electrical and mechanical components of sight transmission.

ASTRONOMY

HARLOW SHAPLEY, PH.D.
Director, Harvard Observatory

THE year is notable above all things in instrumental development, especially in the planning or building of great telescopes. The United States Bureau of Standards has succeeded in casting a glass disk nearly seventy inches in diameter and eleven inches thick, to be made into one of the largest telescopic mirrors in the world, at the Perkins Observatory, Delaware, Ohio. The new sixty-inch reflecting telescope for the southern station of Harvard Observatory has been nearly completed and will be erected, during next year, near Bloemfontein, South Africa. This will be the largest telescope in the southern hemisphere. The Dina Foundation of Paris is reported to have assured the gift to France of a great Alpine observatory, equipped with a large reflecting telescope. Gifts totaling about half a million dollars have been made for the building of a modern observatory at Stockholm, Sweden. Funds are becoming available this year for initiating work on a 200-inch reflector, the greatest telescope of the world, planned for California.

Among the notable noninstrumental developments are contributions from Holland, Canada, and America to the evidence that the whole Galaxy rotates around a distant center in the southern Milky Way, and discovery and measurement at Harvard and Hamburg of clouds of galaxies at distances up to a hundred million light years.

CHEMISTRY

ARTHUR D. LITTLE
Chemical Engineer, Research Inventor

ONE cannot do more than indicate in the briefest way a few of the more important results of the year's great activity in chemistry.

Much encouraging progress has been made in the chemistry of cancer.

There has been a very notable synthesis of cane sugar.

The production of alcohols and other compounds from petroleum and natural gas is an accomplished fact.

Beryllium, the lightest known metal, is now produced in small quantities, and a process has been developed for plating aluminum on other metals.

It has been demonstrated that wrought iron can be produced on a large scale without puddling.

The year has brought many proposals for the utilization of cornstalks and other agricultural wastes as raw materials for industry, and much study is being devoted to the production of protein foods from yeast.

Vitamin D, an essential constituent of foods, is being produced commercially through the agency of ultra-violet light.

Synthetic processes requiring extremely high pressures are rapidly finding a place in chemical industry.

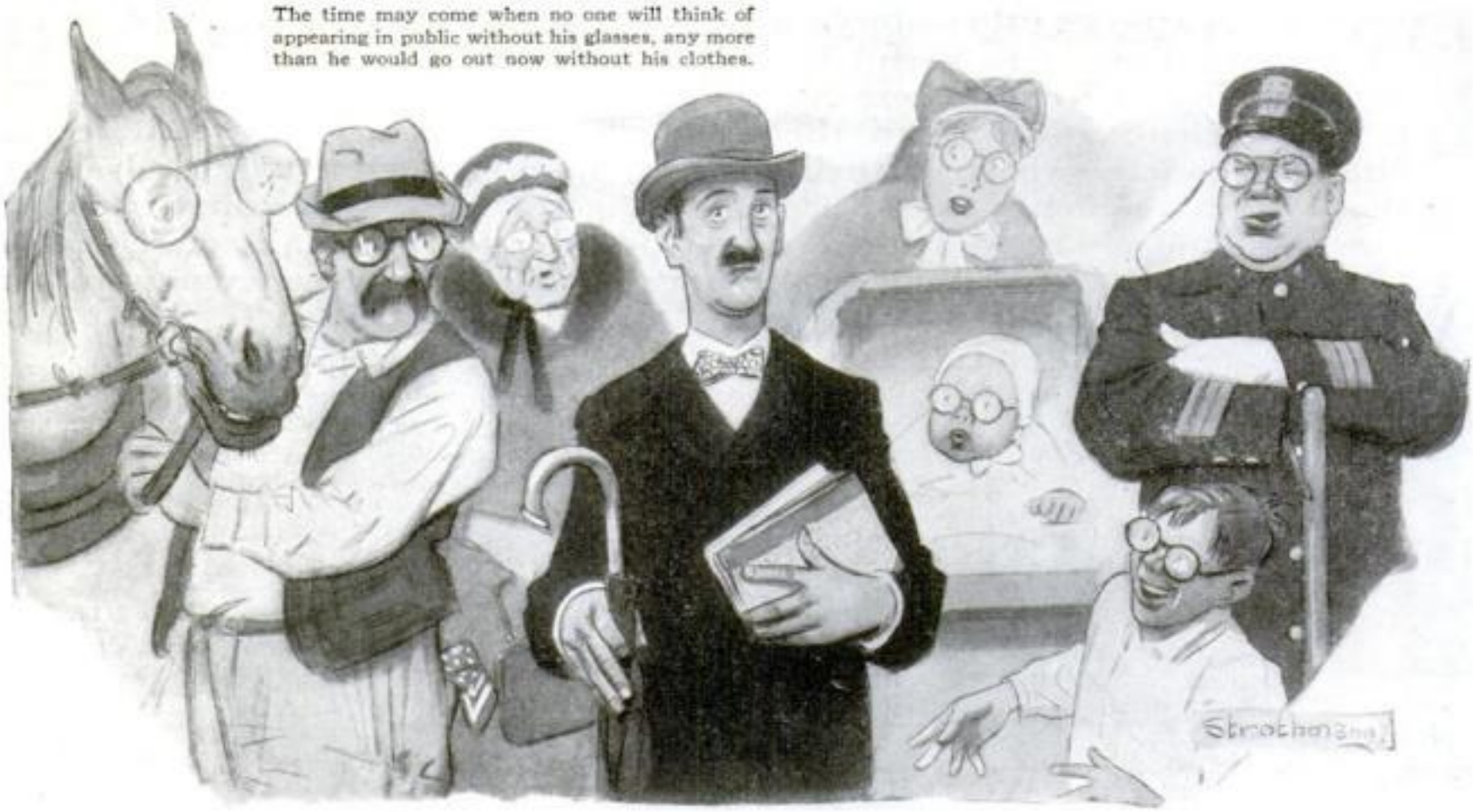
Perhaps the most significant of all developments is the discovery by Dr. Robert A. Millikan of the powerful cosmic rays, which stream upon the earth.

AUTOMOBILES

ALFRED REEVES
General Manager, National Automobile Chamber of Commerce

WHILE no outstanding development marked 1928, trends were important, the most obvious relating to body style. Dame Fashion has added her fickle influence;

(*Cont. on page 138*)



The time may come when no one will think of appearing in public without his glasses, any more than he would go out now without his clothes.

Must We All Wear Glasses?

Surprising Tests Show Why More than Half the World Now Need "Specs"—Interesting New Facts About Your Eyes

By E. E. FREE

EVERYBODY in the world is threatened with spectacles.

The percentage of people whose eyes are already glassed-in increases daily. Nearly half of a group of typical school children tested a few weeks ago by the United States Public Health Service were found to need glasses. Among four million children reported during 1927 to the Guild of Prescription Opticians, more than half proved to be in similar need.

In England, R. C. Raphael, of the National Institute of Industrial Psychology, recently estimated the bad eyes in the working population as between fifty and sixty percent. Dr. Ernest Clarke, speaking before the Royal Society of Medicine, urged that every eye found to be even slightly imperfect be corrected immediately by glasses; which would mean these eye aids for almost everybody, since oculists report that absolutely perfect eyes are virtually unknown.

More significant still is a recent British experiment, just reported by a governmental scientific organization, the Industrial Fatigue Research Board. Going into two typical workshops engaged in fine work, experts of this board persuaded every employee to put on properly fitted glasses, whether he really needed them or not. The result, astonishing to everybody except the experts, was that the workmen turned out more and better work than ever before without being a bit more tired at the end of the day; most of them found, indeed, that they were less tired. Glasses for everybody proved to be the best production stimulant and efficiency improver that those factories ever discovered.

WHEN your eyes feel tired and you are advised to consult an oculist, probably you are inclined to scoff. You believe that the professional charts and lenses, like the strange instrument above, are merely part of a conspiracy to burden your nose with spectacles.

And yet, Dr. E. L. Jones, an authority on nervous disorders, announced recently that simple eyestrain may produce such serious consequences as heart disease, anemia, and insomnia.

The discoveries and tests described in this article are of importance to every man who strives for success in his work.

FROM this to compulsory glasses for every worker, or even for every citizen, is not an unthinkable step. The time may come when every human being will be fitted with glasses on emerging from the cradle; when no one will think of appearing in public without his glasses any more than he would go out now without his clothes.

The usual idea is that all this indicates deterioration of human eyesight. We remember Abraham Lincoln studying law books by the light of the cabin fire or Daniel Boone and Kit Carson recognizing friends or enemies twenty miles away across the plains. Such eyes, we say, *no longer exist. Too much* reading, or artificial light, or some other modern circumstance, has ruined American eyes. Still clearer

How wagon-wheel chart appears to an astigmatism sufferer. Spokes are seen clearly only in one direction.

evidence, said Carrol B. Merritt, New York publisher, recently, is the public's insistent demand for larger and larger type in newspapers, magazines, and books. Small-print books, considered satisfactory by our grandparents, will neither be bought nor be read by the weak-eyed generation of today.

IT IS by no means certain, however, that modern eyes are really worse than those of our grandparents or even of our remoter ancestors of caveman times. Imperfect eyes are nothing new. Two generations ago the great German physicist Professor Helmholtz is reported to have said that if any optician sent him an instrument so imperfect as a human eye, he would send it instantly back. The Italian astronomer Galileo, who died in 1642, is said to have made a similar remark.

But such criticisms judge the eye as though it were a telescope or microscope, suitable only for that one thing and required to be perfect in it. As Sir John Parsons of London pointed out recently, the human eye is a half dozen instruments in one. It is a camera with automatic focus adjustable from an infinite distance to three or four inches. It has a range of sensitivity, without either overexposure or underexposure, thousands of times greater than any photographic plate. It is an excellent light-measuring photometer; it is a colorimeter, a stereoscope, and a range finder, all combined.

AND all these separate instruments are contained in the same tiny, mobile sphere less than a half inch in diameter. Like the jack-of-all-trades who is a mighty useful man to have around after a shipwreck or in any other emergency, the eye makes up in versatility what it lacks in precision. Eyes have served men well for perhaps a million years. Possibly the present world-wide failure of eyesight is because we are asking too much, not because human eyes are going back on the race.

The new British experiment with glasses for every worker supplies a clue as to just what this excessive demand is. The trouble, it suggests, is that we ask our eyes nowadays to do more accurate focusing than ever before and that we insist on maintaining this focus too continuously. In addition to their age-old work as the body's jack-of-all-trades, measuring colors and estimating the intensities of light and fixing the distance of objects in front of us, we demand that our long-suffering optics behave with all the precision of perfect microscopes or telescopes. It is as though some apartment-dwelling family expected a good cook and housekeeper, who could help out also by making all the family's clothes, to be, on top of everything else, an expert piano tuner and able to fix the radio.

Two kinds of work were included in the British experiment. In one of the workrooms people were engaged in threading looms, sometimes handling more than 100 needle-eyes to the inch. The other workroom was devoted to assembling small parts for the interior of electric lamps. In the two cases the prescriptions of the oculists were similar. First, any defects of each worker's eyes were determined and allowed for. Next, the worker was given a pair of spectacles, the lenses of which were adjusted not only to his own eyes but to the precise distance of his work in front of him. Thus the strain of keeping his eyes focused on the work was avoided. His seeing was done at precisely the distance and adjustment easiest for his eyes. It was as though an ingenious photographer, intending to take a great many pictures all precisely alike and at the same distance, should construct a camera focused permanently for that distance and adjusted precisely for that kind of a photograph.

WHEN a photographer focuses a camera he usually screws the whole front of it in or out very carefully and exactly until everything is precisely in focus on the sensitive plate. To do this perfectly, as every amateur photographer knows, is not easy, even with accurately ground lenses, precisely cut screws, and heavy metal guides to hold the camera box absolutely true. Still more difficult is it with the human eye, which is merely a sack of flexible membranes distended by liquid and not held by anything rigid. Even the lens of the eye is an elastic structure, never precisely the same shape for two minutes in succession. It is as though a photographer tried to take first-class photographs by using a lens of table gelatin stuck on the mouth of a rubber hot water bottle to act as a camera.

So long as mankind never had to look at anything much smaller than animals to be hunted or joints of meat roasting in the fire, which were the tasks of Papa and Mama Caveman, a poor eye focus made no great difference.

But times have changed. Everybody reads type, much of which in spite of Mr. Merritt's emphasis on its prevailing enlargement, is still far too small for average eyes to focus on in comfort. Nearly everybody has jobs requiring close and accurate vision of machines or fabrics or something. We have come suddenly to demand of little brother's camera the same grade of work that a hundred-dollar professional instrument would do.

CONTRARY to what most people believe, it is not the lens of the human eye which plays the chief part in focusing it. If our eyes had to depend entirely on their lenses the eyeballs would need to be nearly three times as long as they are, which would make them stick out an inch or so in front of the face like a lobster's. In reality, about two thirds of the work of making a useful image on the sensitive nervous retina of the eye is done by the front surface of the eye itself; by that transparent, sensitive membrane called the cornea, over which the tears flow and which hurts so painfully when the eye picks up a cinder. This cornea is curved, like the bulging front of a lens, and it acts in the same way.

This explains why it is so difficult for human eyes to see under water. If water instead of air is in contact with the front surface of the eye the cornea cannot perform its lenslike duties. The job of image-making is thrown entirely on the real lens inside the eye, and usually proves too much for it. Accordingly, the eyesight of a diver with his eyes open under water is always blurred and imperfect, as though he were wearing glasses badly out of focus. When an eye is in the air the lens needs merely to help the curved front surface, its chief duty being to change the focus

(Continued on page 156)

So long as Papa and Mam.. Caveman never had to look at anything much smaller than an animal, poor eye focus mattered little. But times have changed.

A Fighting Skipper *of the* Air

The Enthralling Story of Dr. Hugo Eckener, Master of the Giant Graf Zeppelin, *the First Air Merchantman*

By ARTHUR A. STUART

SAFELY stored in its home hangar at Friedrichshafen, Germany, the *Graf Zeppelin*, largest aircraft in existence and the world's first commercial dirigible, rested after her record-breaking eastward Atlantic crossing from America.

Greeted with booming of cannon and ringing of bells following a trans-oceanic flight accomplished in seventy-one hours and twelve minutes, the great airship inspired an elated German population with hopes of the speedy establishment of a regular Zeppelin service between the Fatherland and this country.

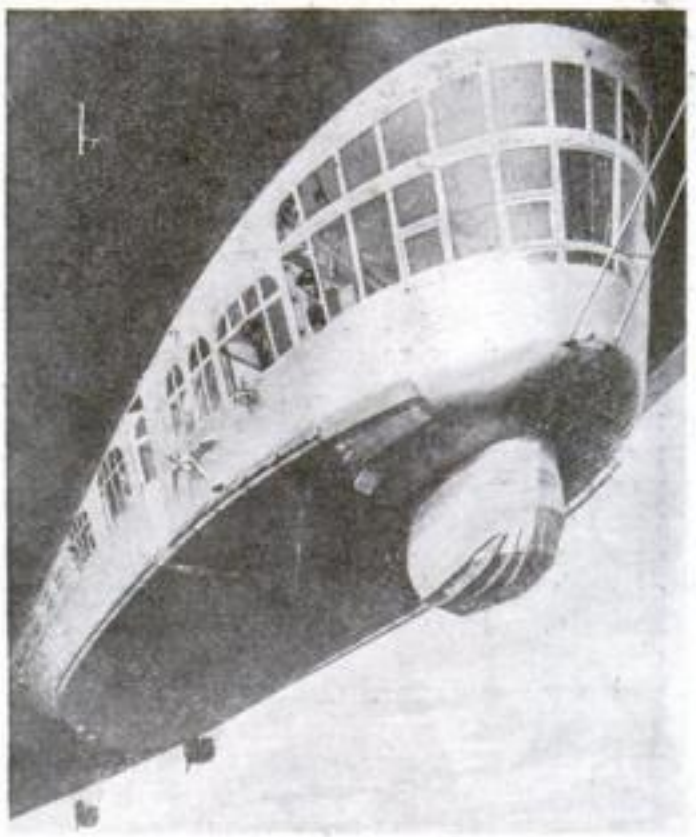
The *Graf's* arrival in Friedrichshafen occurred just three weeks after her departure on a trip to the United States and back. Reviewing the journey, which had been undertaken to demonstrate the possibilities of lighter-than-air craft as passenger and freight carriers, Dr. Hugo Eckener, designer, builder, and commander of the huge air liner, while confident of a rosy future for great aerial ships, did not appear to share the unqualified enthusiasm of his countrymen.

His experiences on both the outward and homebound courses had shown him, Dr. Eckener announced upon landing, that quicker and stronger dirigibles will have to be built before regular passenger service can be established with fair expectation of continued safety and success.

This opinion of his tallied with views he expressed to me shortly after his arrival on this side of the Atlantic. Desirous of seeing the latest wonder of the air, and more especially of meeting the man who constructed her and piloted her safely across the water, I went to Lakehurst, N. J., where the huge Naval hangar, harbor of the proud *Los Angeles*, was to house the *Graf* during her stay in America.

IT WAS 5:38 o'clock of a bleak and chilly autumn evening, when the Zeppelin touched American soil after a storm-ridden voyage from Germany, during which she covered 6,300 miles in one hundred eleven and one-half hours of record-breaking nonstop long distance flight. The builder and skipper of this new leviathan of the air and of her sister, the *Los Angeles*, before her, stepped down on terra firma and quickly crossed the field to the hangar.

Of generous proportions, gray-thatched, ruddy-cheeked, Dr. Eckener resembled a sailor more than a flyer, an admiral rather than an aviator. With his jaunty, clipped moustache and diminutive chin-whisker, his merry blue eyes and ready smile; with his air of well-fed solidity that did not dull a definite sense of thorough-going efficiency, he needed but an opulent velvet costume, sword, and buckled shoes to seem an incarnation of one of Rembrandt's or Van Dyck's portraits of seventeenth century Dutch burghers.



A close-up view of the giant dirigible *Graf Zeppelin* as she settled to touch the soil of America.

WITH the conquest of the air new realms of romance loom in the clouds, new and picturesque figures command world-wide attention. Of these modern Columbuses, few have captured public imagination more than the jaunty skipper who built and piloted the huge dirigible across the storm-swept Atlantic and back. Here is told the picturesque story of Dr. Hugo Eckener and his dramatic adventures.

This portly man, radiating power and good nature, is the master skipper of the air, the idol of the German people, and the hero of two continents.

As he entered the huge naval hangar, he caught sight of the *Los Angeles*, which, as the *ZR-3*, he piloted to this country four years ago. He made a gesture of greeting toward the airship the United States won as a war prize. And a broad smile overspread his features as he exclaimed:

"Da ist mein Schatz!"

Literally translated, the German words meant: "There is my treasure." But colloquially, "Schatz" is often used in the sense of "sweetheart." And so, in the American vernacular, what Dr. Eckener really said was:

"Yes, sir, that's my baby!"

His eyes caressed the "baby"—a 656-foot one!—with a glance as proud and tender as any father ever bestowed on his child.

THE gesture, the words, the affectionate look—they all were typical of the big, jovial Commodore, who, despite his many university degrees, his commanding position as head of the Zeppelin Works at Friedrichshafen, his achievements as a scientist and engineer, and his unique accomplishments as builder and master of the largest aircraft ever conceived, has remained so thoroughly human that thousands of little Gretchens and Fritzes in the German schools volunteered their pfennigs when it became known that "der grosze Luft Kapitaen" (the great air captain) had appealed to his people and government for financial aid in building the *Graf Zeppelin*.

A kindly soul offered him a huge cigar—a veritable Zeppelin among weeds. Lighting it with elaborate care and drawing the first puff, he sighed with intense contentment and said:

"Ah! The first in four and a half days!"

Seldom have I seen so much relish and enjoyment expressed in a human countenance.

Then he was ready to tell the story of the historic flight, for though he had slept only eight hours out of the one hundred eleven and one-half the trip required, he appeared fresh and unwearied.

HE TOLD how he undertook the voyage regardless of bad-weather warnings to prove the air-worthiness of his great ship as a passenger liner and mail and freight carrier. And proudly he emphasized that "the little accident," as he called the ripping of the port horizontal stabilizer in a storm 2,000 miles out over the Atlantic ocean, had served to help him prove his point!

For the most part, he spoke in correct English with a strong Teutonic accent. But every so

(Continued on page 125)

Dr. Hugo Eckener—Builder and Master of Air Liners

His latest answer to critics of lighter-than-air craft is the *Graf Zeppelin*, mightiest dirigible ever launched, which he designed, built, and navigated across the Atlantic, as he did the *ZR-3*, now the *Los Angeles*, four years ago.

REMEMBER the days when it was a popular pastime to see how many automobiles you could call by name as you met them on the road? Well, aviation today has arrived at that same thrilling stage of public interest. So, on these pages, we are picturing most of the leading makes of airplanes now operating in America. How many of them can you identify? Here's a chance to acquaint yourself with the latest flying craft.

Familiar sights at almost any flying field are the diminutive three-passenger Waco biplanes, popular for sport and business. Here are three of them in line. You can identify the Waco by its characteristic round rudder and elevators.

One glance at the trim lines of this monoplane tells you it is built for speed. It is a four-passenger Stinson Junior, and this model is especially equipped for racing. A notable feature is a third landing wheel under the tail of the plane, replacing the tail skid which is common to most airplanes.

Below is another popular sport biplane — the Swallow — photographed in flight above an airport. A distinguishing mark of this machine is the notch in the trailing edge of the upper wing, just above the cockpit. The Swallow is built by a company which is said to be the oldest commercial airplane concern in the United States.

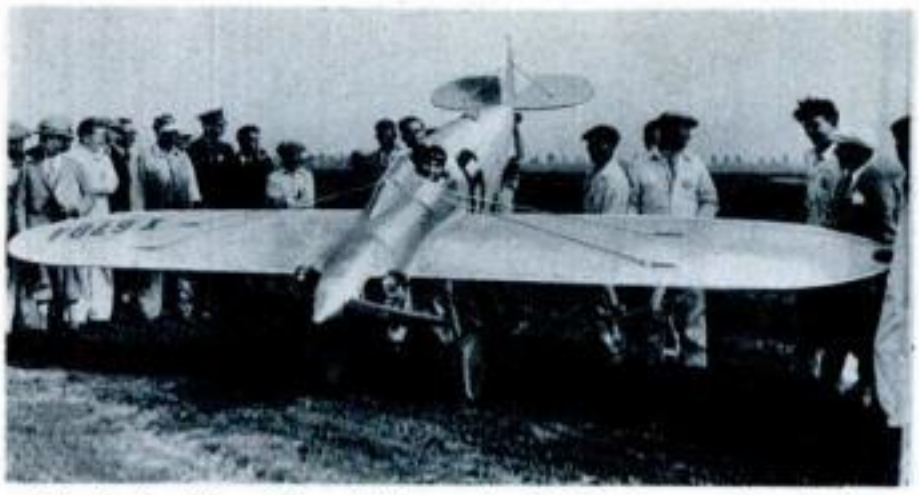
The American Eagle, a biplane for sport and business. Its stream-lined fuselage is sheathed in brilliant burnished metal; otherwise it is a close counterpart of the Waco in general appearance.

The rugged Travel Air cabin monoplane, type 6,000, used by air transport lines for passengers and mail. This photo was taken 10,200 feet up.

The Fairchild monoplane below traveled around the world with Collyer and Mears when they recently set a 23-day globe circling record. Others carry passengers on the eastern Colonial air lines and elsewhere in America.

Left: A Pitcairn Super Mailwing biplane leaving the ground. This machine and others of the same type carry the night mail along the southern route from New York to Atlanta.

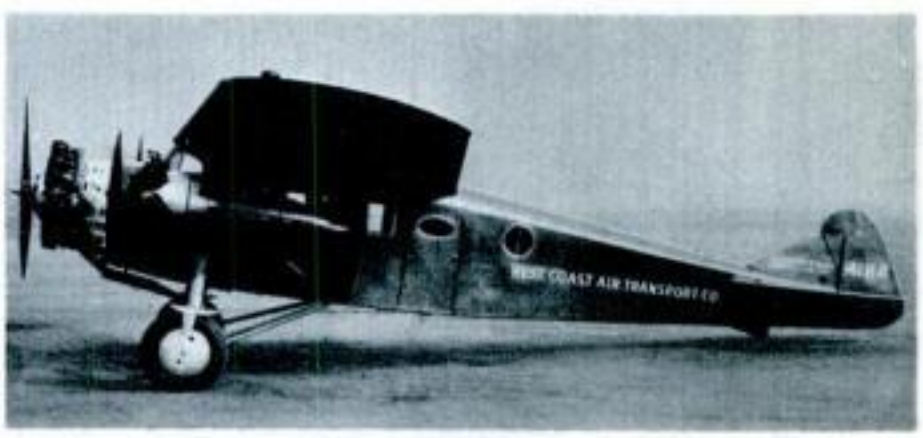
Long, slim lines distinguish the Cessna monoplane, a cabin craft for three or four passengers. Another remarkable feature is the position of the landing wheels, which are placed well forward as an added safeguard against the plane's nosing over in case of rough landing.



Here is the baby of the aviation world—the Heath monoplane. Looks like a toy, doesn't it? But it will carry one person at the speed of 130 miles an hour— if that person is not extra large and heavy. It is one of the smallest of "flivver" planes. In the air it buzzes along like a bug.

They call it the speediest of commercial planes—the Lockheed Vega cabin monoplane, with its odd cigar-shaped fuselage and a top speed of 168 miles an hour. This one is the *Yankee Doodle*, in which Art Goebel recently dashed across continent in record time of less than 19 hours.

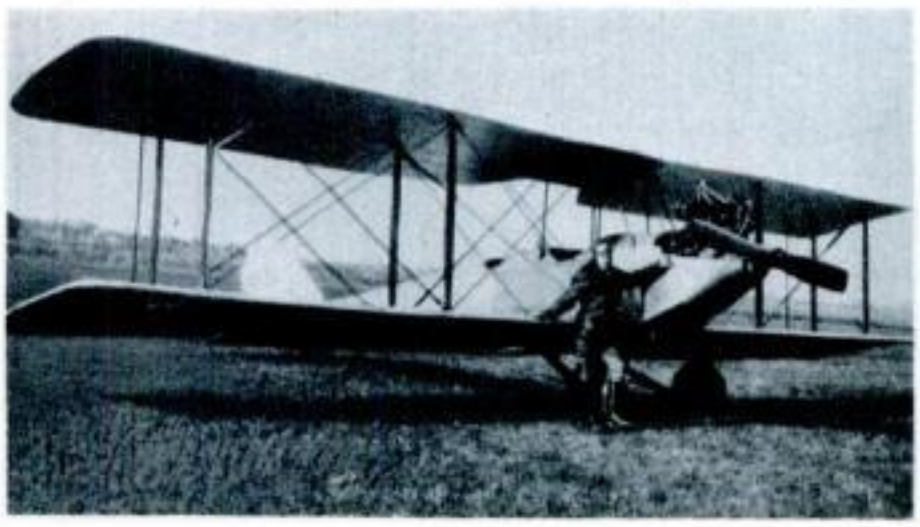
The trim Travel Air biplane, widely used for private flying. You can spot it by the short lower wings, the upper wing notch above the pilot's cockpit, and the pronounced stagger at which the wings are set.



The luxurious Bach "Air Yacht," one of the Seattle-San Francisco planes. It accommodates ten passengers, and boasts a heating and ventilating system, hot and cold running water—even electric cigar lighters.

Here's a real coupe of the air—the Monocoupe, a stubby, sturdy cabin monoplane of strikingly small dimensions. It seats two persons, cruises at nearly ninety miles an hour, and is a popular ship with private pilots.

This handsome Ryan brougham, a sister ship of Colonel Lindbergh's famous trans-Atlantic plane *Spirit of St. Louis*, carries five persons in its cabin and travels at a cruising speed of 108 miles an hour



One of the least expensive of all commercial planes is this Alco biplane, which has been found especially adaptable for use in training student flyers. It has a wing spread of thirty-two feet, and is driven by a 100-horsepower motor. Although not particularly speedy, its stability and ease of handling make it well suited to the beginner's first attempts.

An odd compromise between monoplane and biplane—the Buhl "Airsedan," a cabin biplane with room for four passengers and the pilot. Its lower wing is extremely narrow for a biplane and is set forward at a considerable stagger. Its 200-horsepower motor drives it at a cruising speed of ninety-five miles an hour. The wing span of the ship is forty-two feet.

A Boeing mail plane, photographed in flight over the Ruby Mountains of Nevada. These swift biplanes carry mail, passengers, and express between Chicago and San Francisco, and fly along the Pacific Coast to Seattle.

Above is the "Robin," one of the latest and finest of Curtiss planes. A three-seater, closed cabin monoplane, it is designed to equal a costly automobile in comfort and convenience.

Many amateur pilots fly the slim-bodied Eaglerock biplane, shown at the left flying over Colorado Springs, Colo. Notice that the upper wings are mounted high above fuselage.

A monarch of the air—the massive Stout all-metal cabin monoplane. These great Ford ships are used widely for passenger and express service.

You can hardly mistake the great Fokker tri-motor monoplane, such as Byrd, Amelia Earhart, and Kingsford-Smith piloted on their flights.

Like the famous *Columbia* which spanned the Atlantic to Germany, every Bellanca craft is characterized by extra slanting planes that give the ship the name of "sesquiplane" or "monoplane-and-a-half." The model above will carry fourteen passengers.

A Stinson-Detroiter six-passenger cabin monoplane, like those of the Block-Schlee round-the-world flight and others for Mexico's air mail.

At the left is a Laird three-seater biplane in flight. A speedy craft, it is popular for private and commercial service, and also has been used in long-distance air racing.

The Douglas commercial monoplane—one of the few types of open single-winged planes. A biplane model of the same make is used in carrying air mail.

Another light three-seater, the Stearman biplane. Its short lower wings and shock absorbing struts for rough landings will help you to identify it.

A commercial brother of Army bombers—the ten-passenger Keystone "Pathfinder" cabin biplane—taking off at St. Thomas, Virgin Islands.

THEY FLY or SWIM

A Ryan Brougham seaplane landing on San Diego Bay. Note the angle at which it first touches water. As speed decreases, it settles on even keel.

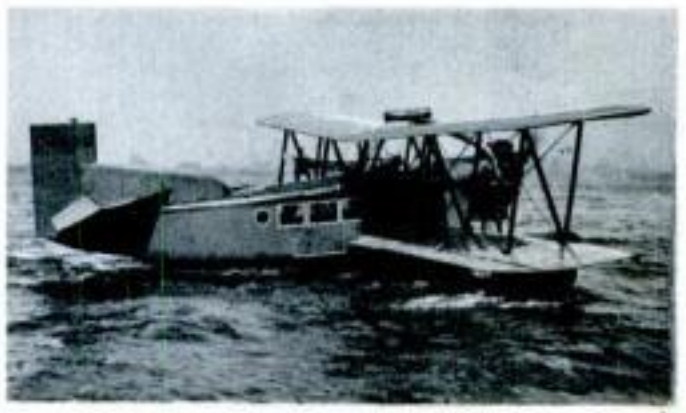
Above is one of the graceful Ireland flying boats, sparing close to the waters of New York Harbor. Its odd-shaped body gives it the appearance of a huge winged fish. Notice how the engine is mounted high and dry behind the wings and cockpit.

Left: One of the mightiest of seaplanes, a Fokker Super Universal, taking off from the Hackensack River, New Jersey.

A sight of the twin-motored Sikorsky Amphibian, above, is one you won't forget. Its distinguishing marks are huge upper wings, dwarfed lower wings, and lofty twin rudders.

For cruises off shore, the Fairchild cabin seaplane offers air yachtsmen comfort and pleasure.

At the left is the Boeing flying boat — a real speed boat with wings. You'll know it by the pusher propeller mounted between the wings, and by streamlined motor boat prow.



Latest model Loening Amphibian, a roomy cabin craft that can alight either on land or water. The wheels fold away into the hull when it is being used as a seaplane.

Swift as a dart is this Army standard pursuit plane, the single-seater Curtiss "Hawk." It can fly 160 miles an hour. The rôle of pursuit planes is to attack the invading enemy aircraft in squadrons. Each plane carries two machine guns.

The Curtiss "Falcon" attack plane. Its function is to swoop upon enemy infantry or tanks and rake them with streams of bullets from its six machine guns. There are bomb racks, too, in its lower wings. It speeds at 140 miles an hour.

Speedy Winged Warriors of the Army

The Loening Amphibian open-type biplane, pictured below, is used by the Army for special observation work. In this it holds the advantage over other military planes of being equipped to alight safely either on land or on water.

One of the Army's standard observation planes is this Douglas O-2H, a powerful two-seater biplane. It can climb to a ceiling of 17,000 feet, or more than three miles—well beyond the range of enemy antiaircraft guns, where it can carry on reconnoitering operations. Its single motor drives it at a cruising speed of 115 miles an hour.

The Keystone "Pirate," at the left, is Uncle Sam's standard light bombing plane. It can loose a ton of death-dealing bombs upon enemy troops and munition depots. At this writing, enormous new bombers are undergoing service tests to pick a heavyweight mate for this lighter type.

Rookie cadets at the Air Corps Flying Schools get their first air rides in Consolidated training planes, like the one shown below. It has tandem seats for instructor and student, and is fitted with dual controls. A Wright motor drives it at a speed of 105 miles an hour.

Another of the Army's modern attack ships is the Boeing pursuit plane. Like the Curtiss "Hawk," it is a single-seater biplane, equipped with machine guns. You can tell it from the "Hawk" by its more tapered upper and shorter lower wings.

A Navy attack plane, the Boeing "Fighter." It is convertible as landplane or seaplane, and can be catapulted from the deck of a warship.

A triple threat to enemy fleets—the twin-engined Douglas plane, used by the Navy for torpedo attack, bombing, and scouting.

Ships of the Navy's Air Fleet

This graceful flying boat is the Navy's PN-12 patrol plane, driven by twin air-cooled motors. Note the two forward cockpits, side by side.

Right: Loening amphibian, Navy model. It rises from water in twelve seconds or is launched from a catapult.

A group of Curtiss "Falcons" of the U. S. Marine Corps Observation Squadron, photographed in flying formation. Falcons can be identified by the characteristic sweep-back of their upper wings, plainly seen in the above illustration.

Landplane, seaplane, or amphibian. The 120-mile-an-hour Vought "Corsair" observation plane can be converted into any one of these quickly. This photo shows it as an amphibian.

Here is the speedy Curtiss "Hawk" equipped with an air-cooled motor for service as a Navy fighting plane. Compare it with the Army "Hawk" pursuit plane on the opposite page. In naval operations, it shares brunt of attack with Boeing "Fighter" at top of this page.

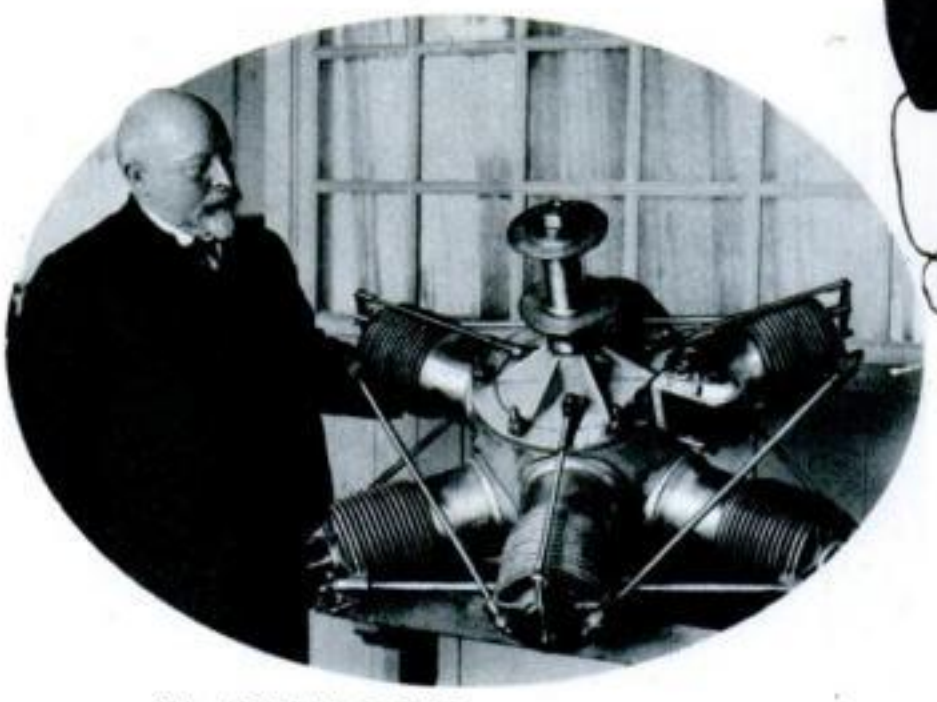
Another of the Navy's triple threats is the Martin torpedo plane at the right. It is a single-motored machine, which has proved particularly suitable in recent tests for transport on an aircraft carrier.

Sidelights of Air Progress

SINCE May, 1926, the planes of one of America's largest air transport concerns have flown more than 3,000,000 miles without injury to a passenger or loss of an ounce of mail or express. Aviation owes its wonderful records of service not to any particular invention, but to hundreds of valuable ideas like those described on these pages.

New Helmet for Pilots

The latest improvement over the clumsy "football" headgear once worn by pilots is this light, close-fitting helmet of soft leather designed by the U. S. Army Signal Corps. Attached earphones and a telephone mouthpiece strapped to the chest enable pilot to hear messages undisturbed by the engine's roar.



The "Whirlwind's" Daddy?

Years ago experts shook their heads when J. C. H. Ellehammer, famous inventor known as "the Edison of Denmark," designed this first radial air-cooled aviation motor. Yet recently, when he exhibited his early model and posed for the above photo, he revealed that it is strikingly similar to its famous present-day descendant, the Wright "Whirlwind," which drove Lindbergh, Byrd, and Chamberlin across the Atlantic.

To Guide Byrd Flyers

When planes of the Byrd Antarctic Expedition begin their explorations over the South Polar ice cap, this new bubble sextant invented by Commander Byrd will enable the pilots to establish their location quickly and accurately. Ralph L. Shropshire, assistant navigator of the expedition, is shown testing the device.

Invents Magnetic Altimeter

Leon Theremin, young Russian professor whose "ether music" device was described not long ago in POPULAR SCIENCE MONTHLY, is seen here with his latest invention—a magnetic altimeter which, he says, tells a flyer his exact height above the earth in thickest fog. The device sets up an electromagnetic field about a recording instrument. This field, says the inventor, varies with the distance to earth; variations are recorded on a dial in terms of altitude.

Map Guides Air-Mail Clerks

So rapidly are air-mail lines increasing that post office clerks have to keep a map of the routes before them while sorting the mails. This picture, taken in the Chicago post office, shows the clerks handling a flood of air-mail letters, guided by a wall map of the various lines. Mail planes now fly 9,000,000 miles a year over lines traversing thirty-five states and serving 62,000,000 people. Ten years ago there was but one line covering 200 miles.

Testing Effects of High Altitude

Sensations experienced by an airman climbing into rarefied atmosphere are duplicated on the ground with a new experimental apparatus (left) devised in Germany. In a steel tank the man being tested is subjected to decreasing air pressure and supply of oxygen. An observer notes the effects.

Gliders and Autogiros to Go on the Market—The Army's New Bomber—Advances in Flying Science

SOON you will be able to purchase your own "training" glider or motorless flying machine, if you desire. In Michigan, according to a preliminary announcement, a newly-formed corporation plans to establish what is probably America's first glider factory. Its first motorless model, towed into the air with ropes by a ground crew and kept aloft by the pilot's skill in taking advantage of rising breezes, is to be known as the PT-1, or primary training machine. A more advanced training craft, and other soarers for experienced glider pilots, will follow later.

Glider flying as a sport in this country received tremendous impetus from the recent Massachusetts glider flights of German experts, who declared that the United States abounds with ideal gliding country. The new manufacturing firm, created to meet the demand for gliders, numbers among its directors Edward Stinson, William B. Stout, Capt. E. V. Rickenbacker, and other nationally prominent figures in the aviation and motor worlds.

New Bombers Fly High

NEW bombing planes which the Army plans to launch during the coming year will be able to drop their deadly missiles from an altitude of more than three miles. The new high "ceiling" will place these craft farther from the effective range of "archies," or antiaircraft guns, according to Air Corps officials. Present bombers have a high-flying limit of about two miles. Moreover, the new craft will be able to drop bombs 200 or 300 miles from its base, an advantage of more than 100 miles over the older type.

Such planes are likely to cause new developments in war tactics. Already it is claimed that a delicate "mechanical ear" developed some time ago to detect the hum of approaching bombers can be rendered ineffective by sending a single scout plane flying close to earth near by. Its roar then drowns out the sounds of the bombers' motors.

Will Market Autogiros

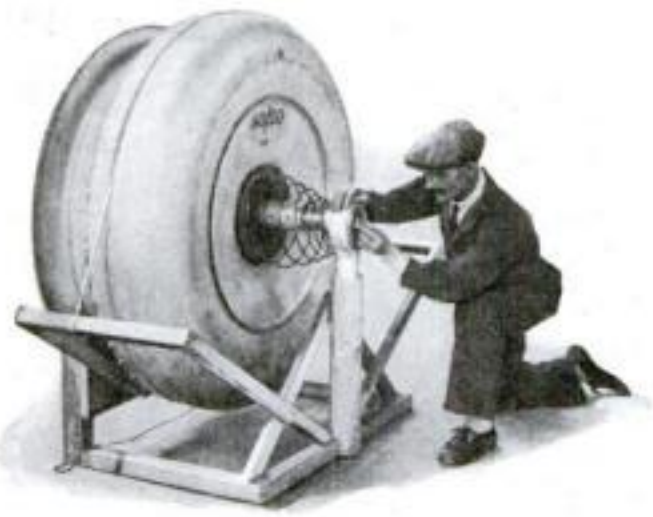
LIGHT autogiro planes are soon to be marketed, according to Juan de la Cierva, inventor of this novel "windmill" type of craft. In initial tests at Hamble Airdrome, England, a two-seater model developed eighty horsepower.

The new model is similar to the larger autogiro in which De la Cierva recently made a successful 1,500-mile tour of continental Europe, as described last month in POPULAR SCIENCE MONTHLY.

Warns of Flying Ailments

WILL man's physique and personality change if aviation becomes as common as motoring? Grave flying ills may become general, in the opinion of Lieut. Col. Levy M. Hathaway, Chief Flight Surgeon, U. S. Army Air Corps. At least two serious ailments peculiar to aviators have already been noted by Col. Hathaway, based on his observations of Air Corps personnel.

Eyes and ears are first to fail, he says. Nearly all veteran pilots are deaf to a certain degree, from continued exposure to motor roar, though all had good hearing when they entered the service. Eye strain and unbalanced eye muscles follow the prolonged eagle-eyed vigil of day and night flying. Other organs may be affected, Col. Hathaway adds, but it is too early to determine their permanent change, if any. However, he has noticed a high degree of neurosis, or nerve affection, among aviators.



Safety Valve for Super-Dirigible

LIVES of passengers on the British military super-dirigible, the *R-101*, now under construction at Cardington, England, will be protected by this huge maneuvering valve which will automatically regulate the gas pressure within the bag. The spring, which the mechanic is adjusting in the picture, holds the valve closed until pressure from within passes the danger mark. Then it allows the valve to open until enough gas has escaped to restore normal pressure. The picture gives an idea of the mechanical marvels embodied in the *R-101* and its sister ship, the *R-100*, which are expected to inaugurate trans-Atlantic passenger service next summer. They are the largest ships of the sky ever designed. Each will be twice as large as the *Los Angeles*.

Water or Air Cooling?

FUTURE ocean-going planes, carrying 100 or more passengers, may employ water-cooled engines, according to L. M. Woolson, Packard Motor Company aeronautic engineer. "Such planes," he recently told the Society of Automotive Engineers, "will demand enormously powerful engines, and it is inconceivable that the great parasitic resistance of many externally-mounted air-cooled power plants can be permitted."

Experts divide sharply on the respective merits of air-cooled and water-cooled airplane engines in general. Advocates of the air-cooled type point to its light weight; its simplicity and freedom from mechanical trouble, as demonstrated in many transocean flights; its rapid warming up, and its lesser vulnerability from projectiles. Champions of water-cooled engines, on the other hand, emphasize that these can be designed with less wind resistance; and that there is greater latitude in the design and placing of the engine, since adequate flow of cooling air is no longer required.

Novel Launching Device

SLIDING planes into the water from ship decks, so that they can take off under their own power, is made possible through the invention of a German engineer named Hammann. In this plan, which aims to rival the present method of launching planes directly with catapults, a slanting platform extends from the ship's deck to the water's edge. A section of sail serves as a sort of cradle to lower the plane into the water, or hoist it aboard again.

Tests of the new scheme are in progress near Warnemuende, on the Baltic Sea. The North German Lloyd steamship line has loaned the liner *Roland* for the purpose.

Cables to Guide Planes

ELECTRIC cables buried underground would guide airplanes across treacherous mountain ranges and into airports, in a new system devised by a French inventor named Loth. Delicate instruments in the plane's control cabin, Loth says, could enable the pilot to follow an earth cable 8,000 feet beneath him.

A similar system has been successfully tested as a means to guide a ship into a harbor. Here the guiding electric line is sunk to the sea bottom.

Dispel Fog by Heat

ARTIFICIALLY warming the open air over a landing field is the latest weapon against fog. In experiments areas up to 200 yards in diameter have been cleared in this way, Lieut. Albert E. Hegenberger, U. S. Air Corps, recently told the aviation section of the National Safety Council. However, it remains to be seen if this method is commercially practicable upon a large scale.

Although calculations indicate that, theoretically, thirteen tons of coal an hour should clear a 400-yard-square field of fog of average thickness and drift, in practice more might be needed due to the heat's dissipation in the open air.

Tragedy Follows Record

THE fog got Capt. C. B. D. Collyer, champion globe-circler, and his passenger, Harry Tucker, the other day. Their famous Lockheed plane *Yankee Doodle*, holder of two cross-continent records, crashed in a fog upon an Arizona crag, killing both.

They had bettered all existing records for speedy crossing of the United States from east to west only a few days before, making the New York—Los Angeles flight in twenty-five hours.

Detectives of Science Solve Mysteries Buried for Centuries

Lost Races Live Again!

Sifting new clues to the romance of ancient Carthage. Count Byron Kuhn de Prorok (right), leader of the Franco-American expedition into northern Africa, and Prof. Henry S. Washington, representing Carnegie Institution, examining mortar from a Phoenician altar. Above: Excavating tomb of Queen Tin-Hinan.

MORE thrilling than fiction are the adventures of the Sherlock Holmes's of archeology, whose latest exploits are recounted here. It is the story of faint trails that lead to strange Mayan cities buried in the jungle; of treasure, ages old, dug from the sands of the desert; of handwriting clues to vanished men.

By MICHEL MOK

THE patient, careful sifting of some sediment encountered in the course of quarrying at Folsom, New Mexico, recently led Barnum Brown, paleontologist of the American Museum of Natural History, to the startling conclusion that America was inhabited by human beings from 15,000 to 20,000 years ago!

These findings placed the beginning of man on this continent in the late Pleistocene period—centuries before the time previously fixed by theories accepted generally.

Brown's revolutionary discovery and the manner in which it was made strikingly illustrate the fact that the archeologist plays the fascinating rôle of a Sherlock Holmes in the drama of modern science. The counterpart of Sir Arthur Conan Doyle's genius of Baker Street lives and labors in the farthest reaches of the earth, where men of knowledge, unquenchable enthusiasm, and unflagging persistence doggedly trace humanity's footprints on the sands of time.

To learn the details of man's life back through the ages and from this rich lore of habits, customs, behavior, and languages to reconstruct his checkered career, these scientists employ the methods that constitute the elements of every good mystery thriller. For breathtaking suspense, tense conflict, and the joy of ultimate triumph after harrowing hardships overcome, the archeologist's adventures not only rival but surpass those of the boldest and cleverest sleuth of fiction.

In the heart of the Yucatan jungles the trail led to these magnificent remnants of ancient Mayan architecture.

He follows slender clues that take him from one end of the world to the other; he sifts to the bottom evidence so slight as to appear useless to the layman; he gathers facts from the test tube and the textbook; he makes deductions from the position and the course of stars; he deciphers codes, the key of which seems often lost in the mists of antiquity—yes, at times he even resorts to what resemble third-degree tactics to force reluctant witnesses to testify.

AND in the end, his unremitting efforts, like those of the hero of detective tales, are crowned with a capture. He captures man in all his weakness, perhaps, but also in all his glory of intellectual, social, economic, and artistic development—man as he emerged from the dawn of primeval periods and slowly grew from a groping, primitive creature into a complex, masterful personality.

Some of the best ingredients that make mystery yarns are contained in the story of Barnum Brown's discovery, which showed that the inhabitants of this continent from 15,000 to 20,000 years ago had attained a degree of culture comparable to that of the prehistoric Egyptians, and which was pronounced by leading scientists in this country and abroad "the best proof ever offered to date of the antiquity of man in America."

QUARRYING at Folsom uncovered a sediment consisting mostly of wind-blown materials. This sedimentation, from four to nine feet deep, was subjected to expert examination. It bore the earmarks of rainfall conditions that have been associated with the retreat of the glaciers in the Pleistocene age.

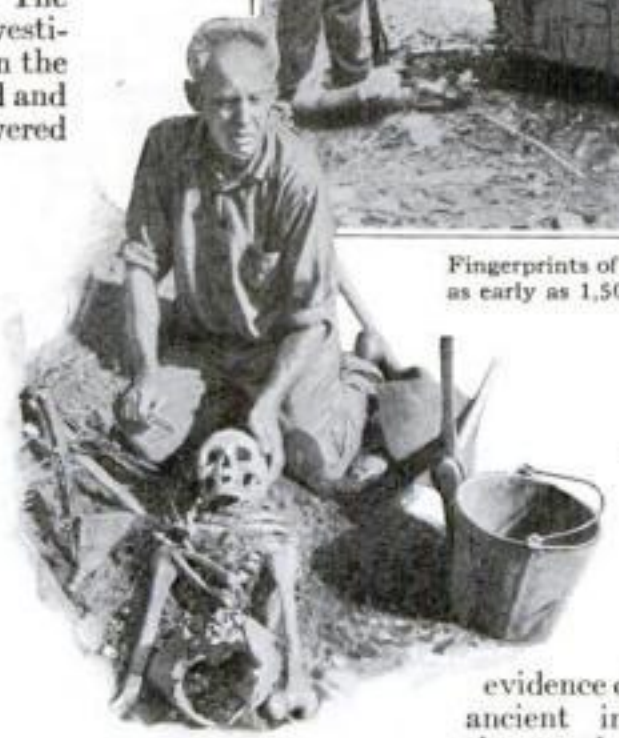
Here was the first clue. The chronological phase of the investigation was established. Then the sediment was slowly removed and it was found that it had covered the bones of a herd of thirty bison of a species long extinct. Next, the archeologist and his assistants came upon the richest treasure. It was a mere handful of some sixteen arrowheads of chalcedony and jasper, fluted and shaped like hollow-ground razor blades. All of the arrowheads but one were broken, but what remained showed a workmanship that equals if not surpasses anything heretofore discovered in America. The fragments of these weapons revealed a technique like that possessed by the early Egyptians. On the basis of this evidence, Brown and his aides reconstructed a distinct culture unrelated to even the earliest manifestations of intelligent human life previously encountered in this country.

Keen detective work by De Moss Bowers, a California archeologist, recently led to equally interesting results. A study of more than 7,000 skulls which he found along Santa Monica Bay gave evidence of the fact that ancient inhabitants of the southern California coast were the world's first dentists!

Bowers saw that teeth had been artificially extracted from some of the skulls. Several of the teeth had "fillings" of pulverized stone and asphalt. He continued his digging with redoubled enthusiasm. Soon he found, among heaps of implements and utensils, what were unmistakably dental instruments, fashioned of bone and shells.

These findings served the archeologist as the groundwork of an extensive thesis, in which he showed that only in one other place dental tools of such an early period had been found. That was at Babylon, but since those instruments were of metal, their origin must have been later. So the fact that the first dentists plied their trade in the region which now supplies the world with movies was scientifically established.

Fingerprints of the Mayan civilization that flourished in Central America perhaps as early as 1,500 B.C.—a stone deity covered with many elaborate inscriptions.



A Sherlock Holmes of archeology, Ralph Glidden, unearths bones of mysterious "white Indians" believed to have lived on Catalina Island, Calif., centuries ago.

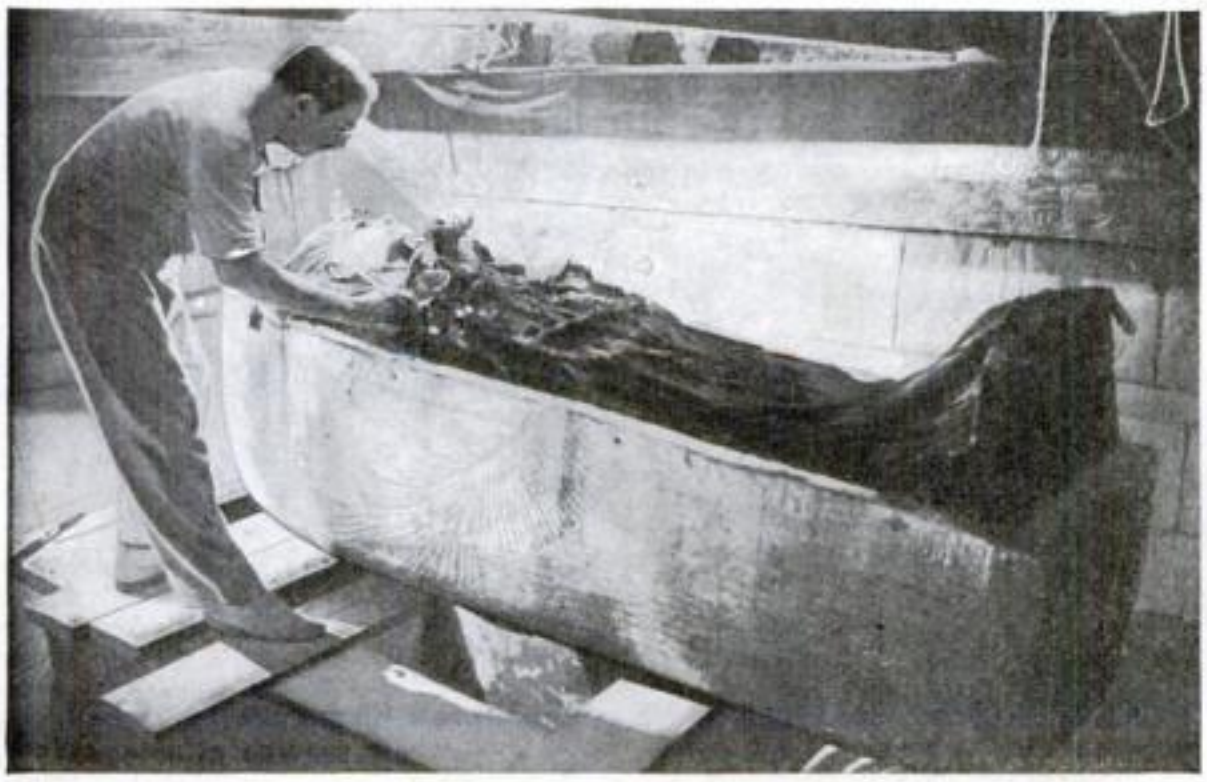
No hero of detective novels ever did a neater piece of work than that accomplished by Auguste Ferdinand Francois Mariette, the world-famous French Egyptologist. Looking for Coptic manuscripts—the writings of the early native Christians of Egypt—in Alexandria, Egypt, in the second half of the nineteenth century, Mariette noticed some sphinxes in the gardens of high officials. When, some time later, he saw similar sphinx figures at Giza and Cairo, the idea occurred to him that all might have been transported from one single ruin.

But where was that ruin? One day, while walking near Sappara, Egypt, he found a sphinx half buried in the sand. At that moment, by coincidence, he remembered Strabo and a significant paragraph written by that Greek geographer 2,000 years ago: "One finds also (at Memphis) a temple of Serapis in a spot so sandy that the wind causes the sand to accumulate in heaps, under which we could see many sphinxes."

A SLENDER clue, but sufficient for a sleuth of the caliber of Mariette! He dug at the sphinx and found an inscription. Eureka! This was Strabo's Memphis. This was the Egyptian Serapum where the sacred bulls were buried with a funeral worthy of a Pharaoh. Mariette gathered a group of workmen, stripped off the sand, and revealed an avenue of 141 sphinxes leading to the massive bull caskets housed in a quarter mile of galleries.

"Elemental, Watson; elemental!"

Another piece of scientific detective work, demonstrating the archeologist's resourcefulness, some years ago resulted



Howard Carter, American archeologist, rolling back the shroud of King Tut-ankh-Amen's coffin. The splendors of the ancient Pharaoh's tomb came as a reward for sixteen years of patient search.

in locating the exact site of the ancient American city of Quivera.

A farmer near Riverton, Neb., plowing his field one day, hit upon a very old, grime-covered saddle stirrup. It looked so strange to him that he sent it to the state museum. Here it was recognized as being the exact counterpart of those used for centuries by Moorish horsemen and Spanish knights.

Uncovering a mysterious buried city in southern Nevada, discovered by a party led by M. R. Harrington of the Museum of the American Indian.

THIS discovery so stirred the Nebraska archeologists that one of them, James W. Savage, made a trip to Madrid, where he delved in the Spanish court archives concerning the expeditions of Coronado, Castaneda Penalosa, and others to the Kingdom of Quivera.

As a result of years of research, Savage and Dr. Robert F. Gilder, of Omaha, succeeded in fixing the location of the City of Quivera, for which Coronado and the old Spanish conquerors searched so diligently and fought so valiantly. They found the ruins of the great ancient city on the Loup River, a tributary of the Platte.

Secret codes! They certainly are recognized by readers of mystery fiction as one of the standard devices of detective tales. When the sleuth manages to decipher the cryptic writing, it is a pretty good guess that the solution of the enigma is close at hand and the book nearly finished. But here is a story of secret writing that was told in instalments covering hundreds of years!

Under sands of the Libyan desert in northern Africa, archeologists are finding treasures of the ancient Roman city of Leptis Magna.

TWENTY years before Columbus discovered America, some travelers among the ancient ruins of Persia were attracted by strange wedge-shaped characters cut in the rocks or molded in little tablets of clay. A few of the tablets were taken to the museums of Europe and kept as curios, and guesses were made from time to time as to what this curious language was.

"Continued in our next!" Nearly three hundred years elapsed before any further progress was made. Then somebody noticed that the wedges were arranged in three different formations. He guessed they were in three languages—probably Persian, Susian, and Babylonian. His guess was an important one, and scholars became interested.

In 1765, the tablets had been studied sufficiently to convince scientists that they should be read from left to right. Then the theory was advanced that a frequently occurring wedge, pointing downward instead of being horizontal, was used to separate the words. After this, progress was more swift.

Several scholarly detectives were certain that they had discovered the signs for a, b, d, and other letters. One thought he had determined at last how many letters the strange alphabet contained. Another decided that a frequently appearing word in the ancient writings was apt to stand for "king" and spent years trying to get somewhere from that slender premise.

Again, "continued in our next!" Some light and more confusion was thrown on the mystery when, in the early part of the nineteenth century, Prof. Christian Lassen, an eminent Swiss scholar, discovered that the "cuneiform language" (for that was its name) was a form of stenographic writing, not very much unlike modern shorthand in principle. Some of the characters stood for letters, others for syllables, and others again for whole words.

In 1847, Sir Henry Rawlinson, then a young British officer, made a great discovery. He found a cuneiform inscription on the rocks of Behistun, chiseled in Greek, Persian, and Babylonian under the personal supervision of Darius the Great, ruler of the ancient Persian empire from 521 to 485 B.C. The key was found at last!

BUT how long did it take Sir Henry to do this little detective job? After an entire year's study, he sent to London a translation of the first two paragraphs, containing the name, titles, and genealogy of Darius the Great.

Is there a sleuth in fiction more interesting than this amateur philologist, using up his annual leave sitting on the hot sands with field glasses pressed to his eyes, trying to read an eternal billboard which an ancient tyrant had carved high up on the rocks to advertise his own fame and prowess?

But Rawlinson's discovery of the key didn't make reading of the tablets an easy task, by any means. It remained an intellectual stunt of the first magnitude to work out a single one of them.

To make a long story short, it was an American expedition, consisting of archeologists of the University of Pennsylvania, that finally solved the riddle. And what a riddle it was! Until this very day the scientific and theological worlds are agog as a result of the revelations. One of the tablets told of the deluge as having happened not 4,000 but 36,000 years ago! Another related the history of the creation and fixed the time at a half million years before that! Another told of Noah, with a Sumerian instead of a Semitic name, and averred that he and not Adam ate of the forbidden fruit!

MUCH closer home is the scene of another remarkable archeological detective yarn, and its time is much more recent, too. Only a year ago, the finesse of an American sleuth of science solved the secret riddle of the Maya calendar.

Yucatan was the home of the Mayas, the dominant Indian race of Mexico and part of Central America at the time of the Spanish conquests; but the first clue to their writings was discovered in a dusty library in Madrid in 1863. The first real advance in solving the enigma was made at Dresden in 1890; important correlations were accomplished at Washington, D. C., in the last twenty years, and the final interpretation of Mayan history in terms of

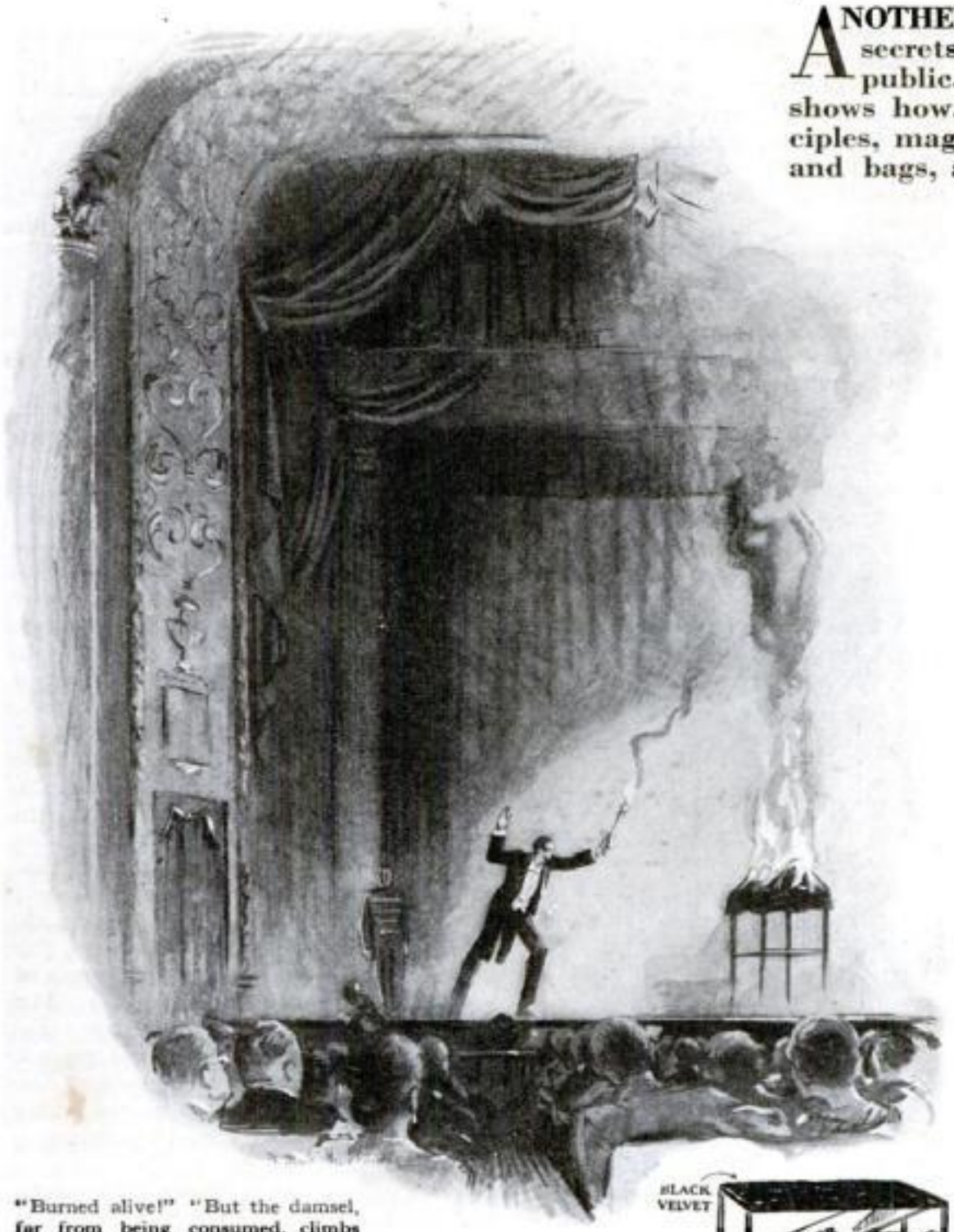
(Continued on page 157)

Ruins of the royal palace in the 5,000-year-old city of Kish, once the center of the mighty Sumerian civilization, whose secrets have been dug from the desert by the Field Museum-Oxford University expedition. The palace covered two acres.

Famous Magic Tricks Explained

ANOTHER absorbing article revealing deep secrets of legerdemain never before told to the public. An expert takes you back-stage and shows how, by applying simple mechanical principles, magicians escape from coffins, water tanks, and bags, and perform all manner of mysteries.

By GEORGE S. GREENE



"Burned alive!" "But the damsel, far from being consumed, climbs out from the pyre and hides in a compartment beneath, as shown below.

IN MY previous article I told of some of the mechanical devices which enable a magician to fool his audience and of the men who spend their time and ingenuity in creating new apparatus for performers to use. I explained how many of the tricks are accomplished by applying simple laws of science. In this article, some of the most baffling feats of legerdemain are revealed as clever utilizing of the products of the workshop and the laboratory.

You probably have seen a magician drop a handkerchief into a glass goblet, wave his hand over it, and presto! the handkerchief is gone. The explanation is simple. The goblet has a partition in it. The partition stands vertically and consists of a sheet of steel cut to fit the glass, silvered and then polished to mirror brightness. Due to reflections, the mirror partition is invisible. The handkerchief is dropped in one side of the goblet and when the glass is turned half around, under cover of the hand, the handkerchief appears to have vanished.

Rubber vacuum cups, such as are used to fasten glare shields to the automobile windshield and advertisements to show windows, are equipped by magicians with a catgut loop and used to vanish billiard balls. The loop, invisible against the hand, is placed over the thumb. The vacuum cup is pressed to a billiard ball in the hands, and with a twist, ball and suction cup are shifted to the back of the hand, quite invisible.

Have you ever offered your gold watch to a magician, and then watched him pound it to fragments in a mortar, and later return it in good condition? Did the magician collect the watch in a little black bag?

The "changing bag" is used to exchange valuable articles for substitutes. It consists of a rim to which is sewed a black silk bag, and fastened to the rim is a black or nickel handle to carry it by. What you do not see is that the bag has a black silk inner partition sewed to a wire half-circle that fits inside the rim. When the magician wishes to "switch" one article for another, he merely gives part of the handle a half turn, which changes the silk partition to the opposite side of the bag. Then he turns the bag inside out after dropping the duplicate from it. Taken off stage, the bag is emptied of the original article by an assistant, who "loads" the article into a loaf of bread or ties it around the neck of a rabbit, to be returned to its owner.

SUCH appurtenances are indispensable to a magical performance, and there are countless others. They combine the inventiveness of magicians since before the days of the famous Cagliostro. They are made in model workshops by men who are specialists in woodcraft and metal-working, electricity, and psychology, and the ideas worked out are, in many cases, equal in cleverness to the products of our modern inventors of airplanes, radio, and electrical devices.

I was once present at the performance of a famous magician whose feature trick was "burning alive a woman." As you doubtless know, this consists of placing a young woman on a stand or table, covering her with a gasoline-soaked screen, and then lighting the screen. At the performance I attended, several women fainted, others screamed, and one man wanted to call the fire department. When the ashes of the screen were cleared away, all that remained on the table was a pile of bones and a skull!

The table, of course, was tricked. Between the top and the floor was a mirror, set at an angle which concealed a compartment in which the girl could hide. The reflections in the mirror caused spectators to imagine they could see through the legs of the table. The girl merely made an opening in the back of the paper screen, descended to the concealed compartment, and placed the bones and skull on the table in her place!

ON A similar principle are based the carnival side show illusions, commonly called "Spidora" and "The Woman without a Body." The mirror conceals the presence of the body, leaving the girl's head resting on a sword at the edge of the mirror.

Since the times of the earliest European magicians, trunks have played a valuable part in the repertoire of the magician. Usually they are used to make young women disappear and reappear. The most common method is to place the trunk on casters and remove the back.

In place of the back is inserted a combination fake back and bottom, fastened at right angles with angle irons. The girl can enter the trunk and, when it is closed, push on the back, which tips out and down to form a shelf on the outside of the trunk. At the same time the fake bottom rises and fits into the trunk back. An illustration at the bottom of this page shows the construction.

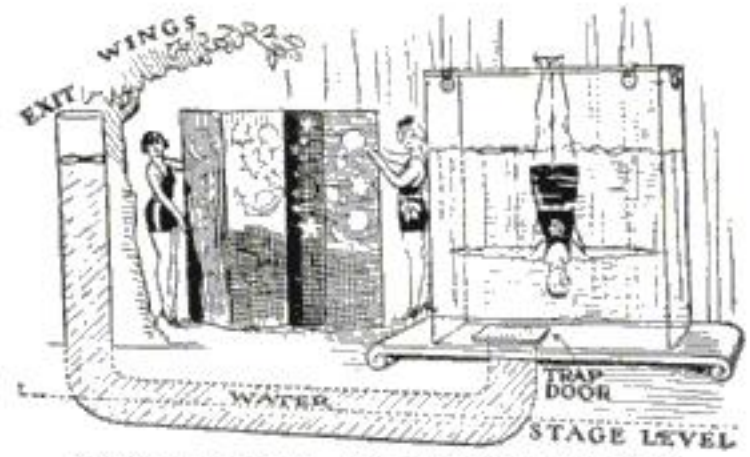
One of the strangest of magical illusions is called "The Rapping Hand" or "The Mummy Hand." Years ago a certain American magician visiting Egypt heard there a story, told by the natives, of a mummified hand of an ancient Egyptian princess which suddenly came to life. On returning to the United States he invented the present-day magical mystery.

The trick consists of a polished board of redwood and a "mummy" hand, which is beautifully made from hand carved wood, and enameled flesh color, the wrist being covered with velvet and a lace cuff. The hand, placed on the board, seemingly comes to life, by tilting the fingers to tap on the board. Usually the hand and the board are passed among the spectators for examination.

The trick water bowl. At first exhibited empty, it mysteriously fills itself again and again. The trick lies in a secret water compartment punctured by a small hole. As long as the magician keeps his finger over the hole, the bowl is empty; removing the finger lets water flow in.

A DRAWING at the foot of this page shows the construction of the board, and how it controls the movement of the hand. On the underside, at each end, are small wooden strips, fastened to the board with screws. One of the screws is "faked"; in reality, it passes through the board, connecting with a leverage device that forces a needle-like plunger to rise from a tiny hole in the top of the board. The plunger is operated by pressing the screw, and the latter can be locked, immovable, by giving it a half turn. The hand is merely placed over the plunger, which causes the wrist to rise and the fingers to strike the wood!

One performer, well known as a magician, but essentially an "escape artist," achieved fame in the United States and abroad through his uncanny ability to escape from a locked steel vault. Once inside the vault he removed a tiny flashlight, can of oil, and screw driver from concealment on his body, and with these removed the vault manufacturer's name plate from the inside of the vault door. This exposed the tumblers, which he was able to manipulate and so open the door. He then replaced the plate, wiped the oil from the screws, stepped out, and relocked the vault. The escapes were pronounced miracles, and spiritualists gave him credit for dematerializing himself. Such is fame, secured through a knowledge of mechanics and psychology.



"Water cell" escape. The magician plunges into a water-filled glass tank. Screened momentarily, he vanishes through trapdoor to water pipe under stage.

The appearance of a coffin on the stage always sends shivers through the audience. Several magicians have taken advantage of this by escaping from coffins. The performer is strapped into a straitjacket and placed in the coffin—a genuine one borrowed for the purpose from a local undertaker. The top of the coffin is strapped down. The performer makes the seemingly impossible escape in several minutes, inside a cabinet. A knowledge of mechanics does the trick. He slips the straitjacket up over his head slowly in the customary escape manner, and, when free, takes advantage of a fact that the layman does not generally know; that is, that with most coffins, the lid is in two parts, the upper part being removable so that the body of the dead can be viewed from the waist upward. It is out of this opening that the performer makes his escape, and another "miracle" is performed.

Hidden springs expand folded flowers.

It is easy to escape from a sack into which you have been tied—if you have the nerve. The professional magician wads up his handkerchief and places it in the neck of the sack when it is tied from the outside. When a screen has been placed around the sack by attendants, the magician pulls the handkerchief out, thus leaving plenty of slack in the rope around the neck so that he can easily work the rope upward and off.

Among the countless present-day magical innovations that have given fame to their inventors, the escape from a "water cell" stands prominent. It depends entirely on a well-known but unsuspected scientific principle; dozens of magicians have attempted to imitate it, but without success.

A large cell, or glass inclosure, is exhibited in the center of the stage. It apparently consists of a number of sheets of plate glass joined into an inclosure with rubber gaskets so as to be water-tight. What makes the illusion so puzzling is that the "water cell" can be distinctly seen through. The glass tank is filled with water, into which the performer plunges. The tank is immediately concealed with screens, and when again revealed, the performer has escaped from it.

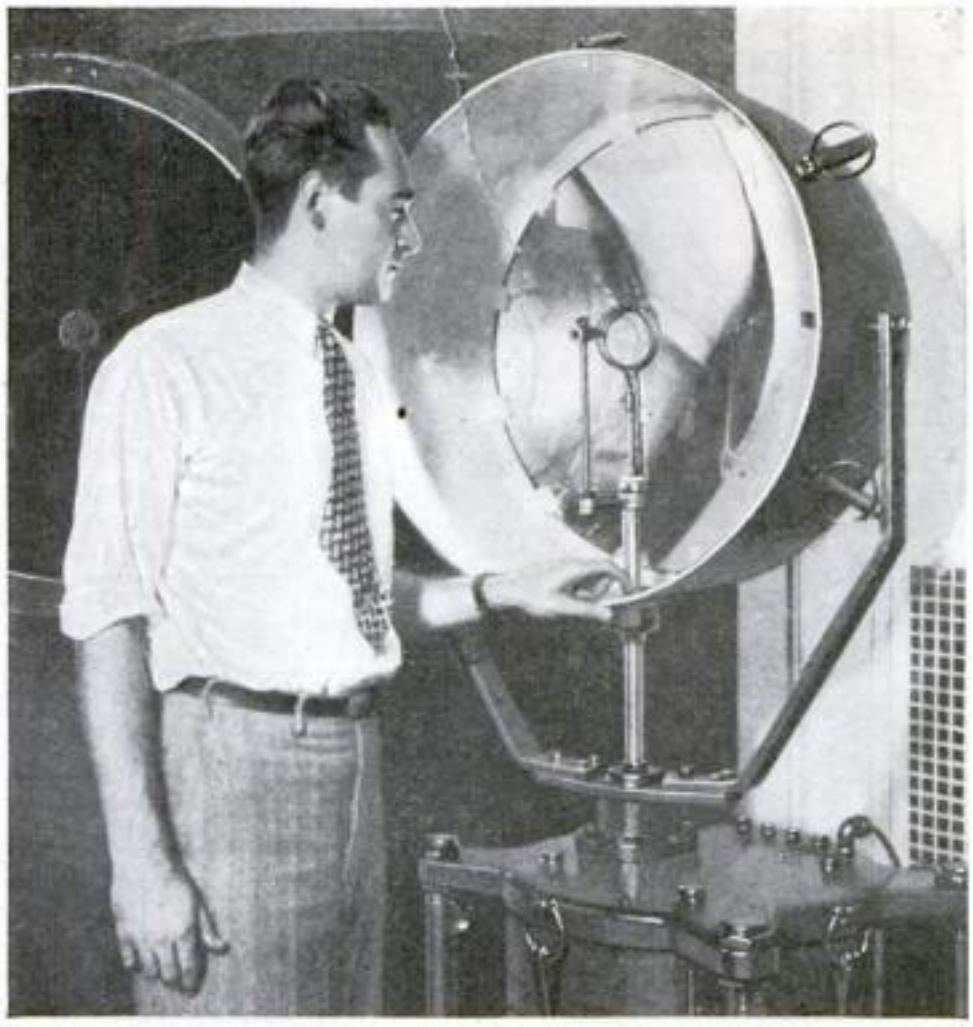
The escape depends on the fact that water seeks its own level. A metal tube large enough in diameter for a man to crawl through leads from a trapdoor in the bottom of the tank, underneath the stage, and emerges behind the side drops, extending up to the same height as the glass tank. The trap door is made of a square of glass without hinges, the under side being covered with a piece of wood matching the tank platform. The performer has merely to slide the trapdoor aside, enter the tube, and replace the door; then crawl to the exit at the other end of the tube, where the water rises to the same level as in the tank.

ONE can apparently see underneath the tank, because the tube, where it connects with the trap, is concealed behind a black drapery matching the backdrop and therefore invisible. To perform the feat, one must, of course, have the ability to stay under water for the minute or two required.

In the same category as the "walking through a brick wall" trick, described in a previous article, is the "Packing Case Escape." A large wood shipping container is obtained from a "local" store, and "local" men nail the performer into it. Various methods of escape are used; "fixing" the box just before the performance is the most common. Fixing is accomplished by removing certain nails in the box, cutting them in half, and reinserting the head part back in the holes. Other performers carry their own boxes, with carpenter-made trick panels for an exit. The simplest method used, however, is a leverage device, which can be collapsed to fit into the performer's pockets. Once inside the box, he can put it together again (Continued on page 155)

The "Mummy Hand." A plunger, operated by fake screw, makes fingers tap on board.

Locked in the trunk, the girl reappears! She simply pushes on the fake back which tips down, lets her out, and again closes the trunk.



New type of revolving neon airport beacon. The glass bulb at center contains neon gas. Energy from a surrounding electric coil causes it to light.

Neon, Magic Gas

That Lights the Way

Through Fog

By H. C. DAVIS

FLAMING letters of scarlet sixty feet high flash the word "RICHFIELD" from a hill overlooking Portland, Oregon. Completed a few weeks ago, they form what is said to be the largest electric sign in the world. A three-story house could nestle comfortably under the cross-bar of the "H". The monster display serves as an aerial beacon and landmark, besides advertising the product of the oil company that erected it; for the 725-foot row of letters can be read more than twenty miles away!

From one end of the country to the other, today, appears the familiar red glow of these "neon" signs—so called because their glass tubes contain the strangest of rare gases, neon, captured and isolated from the atmosphere, its native haunt. They advertise banks and factories, moving pictures and biscuits. Beacons, too, of scarlet neon light, pierce fog and mist to guide airplanes safely to port. Returning the compliment, one great airplane, the largest commercial machine in the United States, displays on its lower wing a huge neon advertising sign to flash from the sky the merits of a cigarette or auto oil. In widely diverse fields—television, for instance—neon is pressed into service.

ALL this has happened recently; yet this year is the thirtieth anniversary of neon's discovery. And the process by which it is made today is surprisingly similar to that by which Sir William Ramsay, English chemist, first found it. Distilling liquid air chilled to the inconceivable cold temperature of more than 400 degrees below zero, F., he observed a strange gas boiling off. This he named "neon," meaning new. Today in great factories neon is made by chilling air until it becomes a clear bluish-white liquid and then capturing neon as it evaporates away.

For neon is everywhere in the air, mixed with the oxygen, nitrogen and other constituents that you breathe daily. But so small is its actual quantity that in three or four hours you will have breathed but a single lungful of neon. There is only a thimbleful in as much air as you could put in a railroad tank car; specifically the proportion is about twelve parts in a million of air.

A pound of neon would cost you about ten thousand dollars. This curious, colorless, inactive gas does just one thing and does it so well that it is many times worth its weight in gold. When an electric current is passed through it, in a near-vacuum, it glows with the peculiarly brilliant fiery-red tint that by now is familiar to every American.

Makers of electric signs buy the neon gas in thin-walled glass bulbs, each containing about a quart. Of course the colorless gas within is invisible; a full bulb looks the same as an empty one. Every precaution is taken to avoid breaking, else the precious gas, worth about $20 a bulbful, would escape back into the air whence it came. Hollow glass tubes are twisted, by a combined heat and blowing process, into the fantastic shapes required to make script letters and advertising text. Air within them is sucked out by a vacuum pump. Then a bulb of the neon gas is hooked on, a valve turned, and the gas slowly hisses into the tube. One bulb contains enough gas to fill two or three hundred feet of average-sized tubing, for only a little is required; so little, in fact, that the pressure within the finished tube is but the tiniest fraction of the outside atmosphere's—often a hundredth part of it or less.

IN THIS near-vacuum, an electric current does strange tricks. It can leap across great distances that would utterly baffle it in air. Instead of sparking, it makes the surrounding gas glow with a broad, diffused light. When neon gas surrounds the two electrodes sealed within the tube, a brilliant scarlet tongue of fire leaps between them. There is no glowing filament, as in an ordinary electric lamp bulb—only the curious cold, pulsing light of the gas itself.

It need not be red. If a couple of drops of mercury are inserted in the tube of neon, for example, its light becomes a brilliant blue. Still with the mercury added, but in a yellow-tinted tube instead of a colorless one, the light becomes green.

So intense is this light that neon advertising signs can be seen plainly in broad daylight, as well as at night; and many stores keep them lit all day. Their characteristic hue is an attention-drawing contrast in a

(Continued on page 150)

Courtesy Claude Neon News

A typical neon sign, visible in flaming red day or night, and extremely economical.

D. Macfarlane Moore (left) and Dr. E. F. W. Alexanderson, with neon lamp designed for television.

Links in the Chain of Science

By KARL VOOGHT

WHAT'S the good of science? Every now and then such a query comes from somebody who sees in it only a cold intellectual subject remote from life. And the answer is like an endless chain—it starts anywhere and keeps on going forever. Consider, for example, as I did, the bits of news that flow over a single desk in the office of POPULAR SCIENCE MONTHLY in just one week.

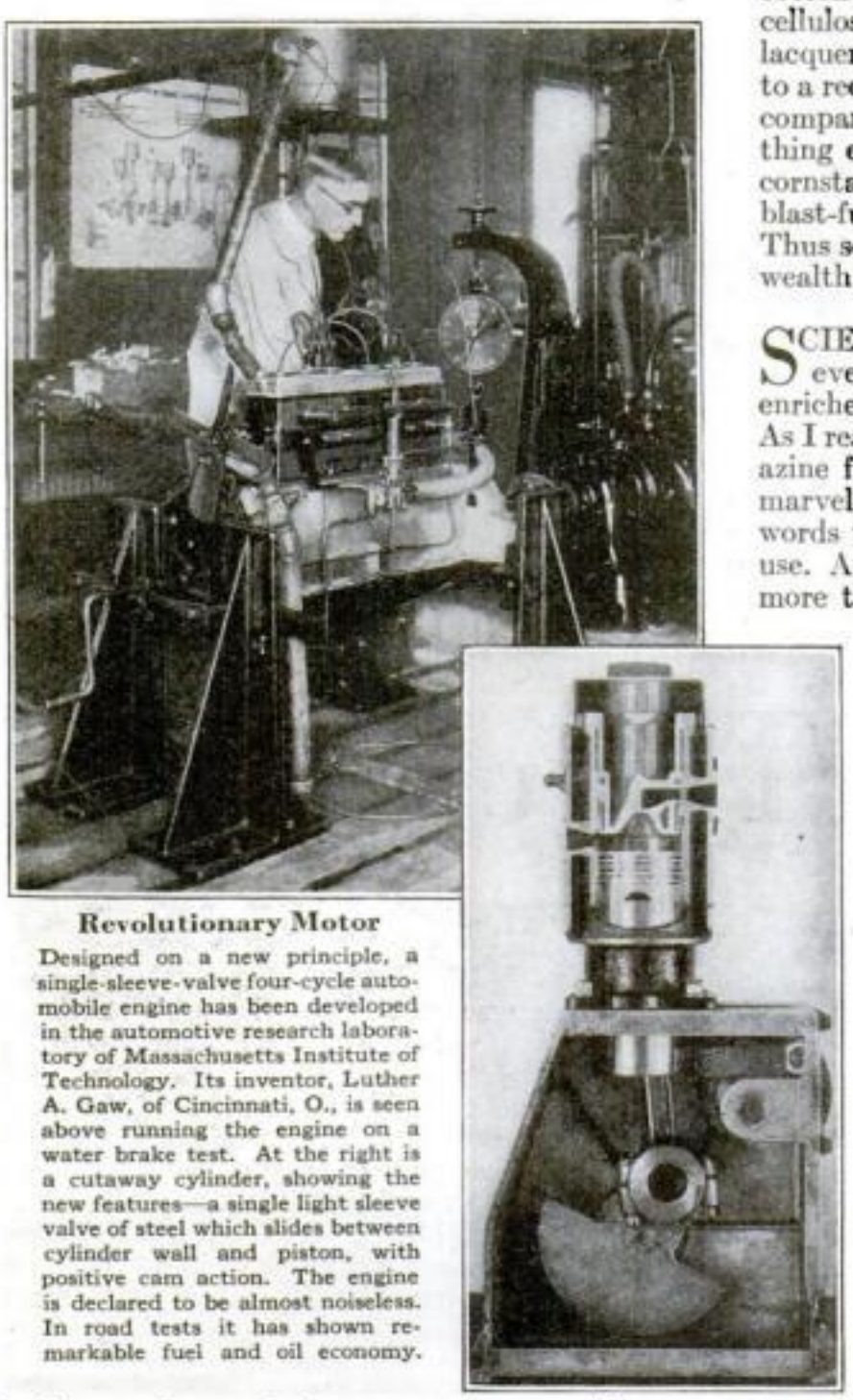
Here is a report of a dancing mouse that for nineteen hours leaped about and chased its tail the other day while it breathed, in safety, nothing but illuminating gas. And as a result, before long, we may be able to light our houses and cook our meals with gas which can be breathed in quantity without danger or discomfort.

One of the prices humanity pays for convenience and liberation from labor has always been a greater hazard of accident. Speed by rail, by automobile, and by air has been achieved at the price of safety. Gas as fuel has been far more convenient than the fire pots of pioneer days, but the toll of deaths from asphyxiation from gas leakage mounted yearly. Then Dr. Arthur D. Little, of Cambridge, Mass., developed a simple method of converting ordinary illuminating gas into the harmless gas tested on the mouse. Besides being safe, it retains all of its heating properties and in the conversion process yields valuable by-products.

A FEW years ago, it was predicted that gas as a fuel and illuminant would be displaced by electricity and that all gas-generating plants would be abandoned. This has not happened because gas engineers, put on their mettle, waked to discover new uses for gas in the home. The American Gas Association now is attempting to develop a refrigerator-furnace capable either of heating or cooling a house. The scientific fact underlying this apparent paradox is that ammonia—not household ammonia, of course, which is a solution of ammonia in water—has a boiling point of twenty-seven degrees below zero. Ammonia, circulating in coils, absorbs heat from the air. In cold weather this property will be utilized to absorb sun-heat from outside the house, in summer to absorb heat from within. As a theoretical proposition, this sort of furnace-refrigerator is entirely possible; its translation into a practical device is a matter of engineering.

Far from being dry and uninteresting, science has an intimate, personal connection with the everyday affairs of our lives. Utility, practical application, the satisfying of some existing human need—these have always been the results of science and the driving power behind each new scientific achievement.

For years engineers have sought for better methods of building roads. The automobile has multiplied their problems many times. Hundreds of materials have been used, including even blocks of rubber. And now, from Paris, comes a report of an entirely new—and successful—paving made of blocks of cast iron. Highway engineers there announce that the iron surface wore less than any other paving and motorists reported that the tiny cracks between the blocks reduced the danger of skidding. The engineers point out that the pavement is constantly protected against rust by oil from motor cars and that the iron cannot be worn into ruts. The experiment will prove especially interesting in England where oil and asphalt, washed into roadside streams by rain, are believed to have killed fish.



Revolutionary Motor

Designed on a new principle, a single-sleeve-valve four-cycle automobile engine has been developed in the automotive research laboratory of Massachusetts Institute of Technology. Its inventor, Luther A. Gaw, of Cincinnati, O., is seen above running the engine on a water brake test. At the right is a cutaway cylinder, showing the new features—a single light sleeve valve of steel which slides between cylinder wall and piston, with positive cam action. The engine is declared to be almost noiseless. In road tests it has shown remarkable fuel and oil economy.

And no one who ever used the telephone can fail to be interested in this report from London of the invention of a device to record telephone messages. For more than thirty years scientists have tried to develop a practical system of sound reproduction that can be attached to the ordinary instrument so that messages coming in our absence can be saved for us. This London machine reproduces the speaker's voice in full volume and with clarity and accuracy. Such a device will interest particularly doctors, lawyers, and other men who must be away from their offices for long periods.

Seed hairs, shaved from the hulls of cotton seeds, are being made into nitrated cellulose for the production of explosives, lacquer, and photographic film, according to a recent announcement of the Du Pont company. Waste wood, unfit for anything else, produces commercial alcohol; cornstalks make paper; "worthless" blast-furnace slag is used to make cement. Thus science produces "magic money"—wealth from the scrap pile.

SCIENCE never stands still. It changes everything it touches, improves and enriches it. It even changes our language. As I read the reports, coming to this magazine from every corner of the world, I marvel at the number of new words I see, words that one day will be in everyday use. A brief investigation showed me that more than a quarter of a million words that the dictionary-makers of 1900 never heard of are in the books today, and the number grows by thousands every year. Possibly the newest is "nemo," which is pure Latin for "nobody." Thus radio broadcasting technicians refer to a stadium, hall, or distant studio from which a program is being transmitted to the broadcasting station over a telephone wire as a "nemo station."

Just as new is the word "perminvar," the name of a new metal, the characteristics of which are its high magnetic permeability and the invariability of its behavior under magnetic influence. The name is a compound of the two words "permeable" and "invariable." Perminvar is a compound of iron, nickel, and cobalt.

Behind it is an interesting story beginning several years ago when Dr. G. W. Elmen, of the Bell Telephone Laboratories, discovered that an alloy of iron and nickel in certain proportions and under certain pressures was forty times as responsive to magnetism as pure soft iron, previously regarded as the most magnetic of all substances. That alloy was named "permalloy," and one of its first applications was the "loading" of the high-speed ocean cable between New York and the Azores.

A THIN ribbon of *permalloy* 7,500 miles long wrapped around the cable core so accelerated the speed of signals that more than six times as many telegraph messages can be sent in a given

Brief Bits of Fact and Interesting Comment; a New Feature Portraying the Drama of Progress

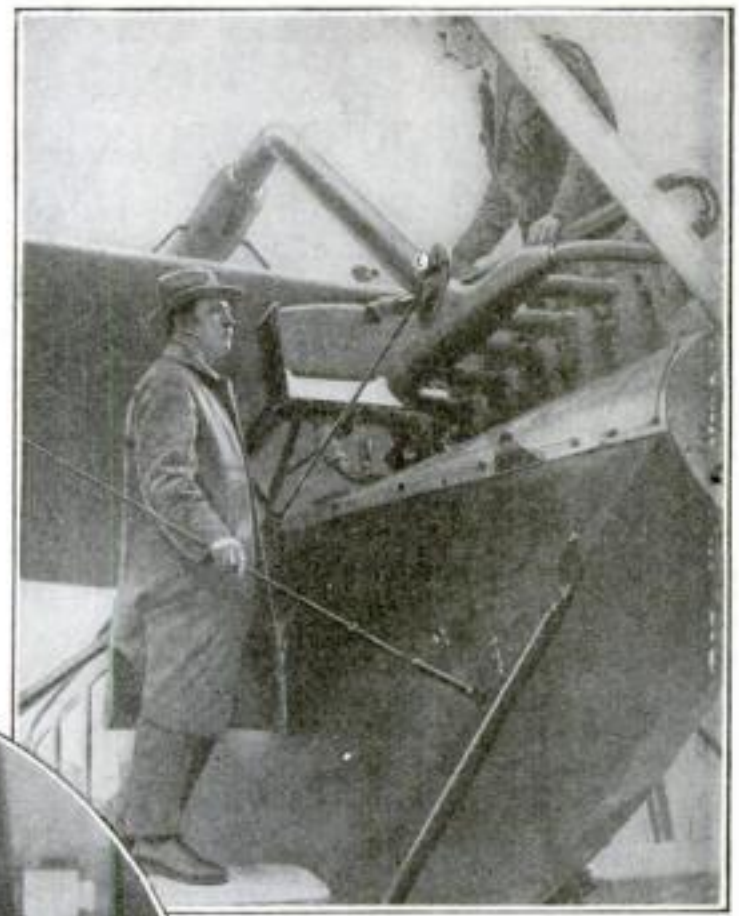
time as over the old-style cables. Dr. Elmen continued his research and found that by adding cobalt to the iron-nickel alloy he had a substance not so magnetic as permalloy but which loses no energy in being magnetized and demagnetized. A modification of permalloy known as mu-metal was used in loading the new Western Union telegraph cable from Newfoundland to England, the first deep-sea cable capable of carrying messages in both directions at once.

NOW, by the use of perminvar, it has been found possible to carry telephone conversation through a cable much greater distances than has been practical heretofore. The telephone cable now being constructed to connect America and Europe will be "loaded" with this new alloy, thus increasing its efficiency and probably cutting the cost of transoceanic communication.

Here's another new word: "carboloy." That is the name of a new metal which will cut a screw thread on a glass rod, bore a smooth hole in a block of concrete, or cut porcelain on a lathe, feats which have been regarded as impossible. Carboloy was developed by Dr. Samuel L. Hoyt of the General Electric Company, and is an alloy of tungsten, carbide, and cobalt. The hardest cutting tools heretofore in use, alloys of chromium and cobalt, have to be sharpened after being used less than 200 times; carboloy tools can be used 11,000 times before resharpening! Ordinary steel tools are worn down by an emery wheel; carboloy tools wear down the emery. One valuable use already found for carboloy is in cutting composite gears for automobiles, which are built up of molded material with metal inserts.

"Xenon," a word nearly twenty years old but as yet unfamiliar, is the name of one of the six gases which make up the air we breathe. Four fifths of the air is oxygen, one fifth nitrogen mixed with argon, xenon, krypton, and neon. Argon constitutes about one hundredth of the nitrogen mixture and the other three together are about one four hundredth of the argon content; so less than one two hundred thousandth part of air is xenon. These rare gases are in demand by scientists studying the effect of electric charges in a vacuum, studies without which radio and television, for example, would be impossible. Neon lamps give off a brilliant light so penetrating that neon lights are now beginning to be used as aviation beacons, being visible through fogs which conceal other kinds of light.

Means of extracting neon from the air cheaply, for this purpose, have been found, but the recovery of xenon and krypton is so expensive that the cost of samples for laboratory purposes compares with that of radium, a value of almost $13,000 a quart being placed upon xenon. And now the famous French physicist, Georges Claude, reports to the French Academy of Sciences that he has extracted several quarts of xenon from the atmosphere in a single day. With xenon made available in quantities, we can be sure that some way will be found to convert it to human use. One use might be in a fog penetrating device to increase the safety of airplanes.



Muffler for Airplanes

With a new type of muffler attached to the exhaust, a Norwegian inventor, Bjarre Carlen, claims at last to have solved the problem of silencing the airplane's roar without seriously reducing the power of the motor. Loss of power due to back pressure in mufflers of the type used on automobiles heretofore has made their use in the air impracticable. The photograph above shows the inventor inspecting an installation of his device.

"Steelless Steel"

Second in hardness only to the diamond, an amazing new metal alloy tougher than steel called "carboloy" is being applied to making cutting tools by the General Electric Company. The metal is made of tungsten, carbide, and cobalt, and was developed by Dr. S. L. Hoyt of the General Electric Research Laboratory. Here he is shown exhibiting a cutter made out of the new material.

Tests Show What Clothes to Wear

To receive the most benefit from the sun's health-giving ultra-violet rays, you should wear white loosely-woven clothing, made of cotton, linen, or rayon rather than wool, according to results of recent U. S. Bureau of Standards tests of various cloths with the apparatus shown above.

Science moves its products rapidly from the laboratory into everyday use. Most of us remember when automobiles were called "horseless carriages," when airplanes were considered impractical, when radio was unknown. Yet today there are more than 20,000,000 automobiles in the United States. We no longer marvel at the airplane. There are radio sets in nine or ten million homes.

AND today, in addition to military planes, there are over 10,000 licensed commercial planes in use in the United States. In another ten years, there may easily be fifty times as many. When that time comes, the sky will be filled with the sound of engine exhausts and propeller hums unless effective silencers are developed. Far-sighted scientists in Europe, as well as in America, are working diligently on this problem.

Silencing the engine is not especially difficult, and one Norwegian engineer, Bjarre Carlen, working in Berlin, reports the perfection of an invention that silences his motor. His (Continued on page 131)

Strange Fires that Start Themselves

By JOHN E. LODGE

DID you know that an air bubble in a window pane, wet lime, or piled newspapers, may mysteriously set your house afire? If not, you'll be interested in this story of strange spontaneous conflagrations and of the surprising ways in which they start. It is one of the most amazing stories you have ever read.

Spontaneous combustion in tightly stacked newspapers or rubbish is now known to start costly fires such as this. Confined heat in the inflammable mass ignites it.

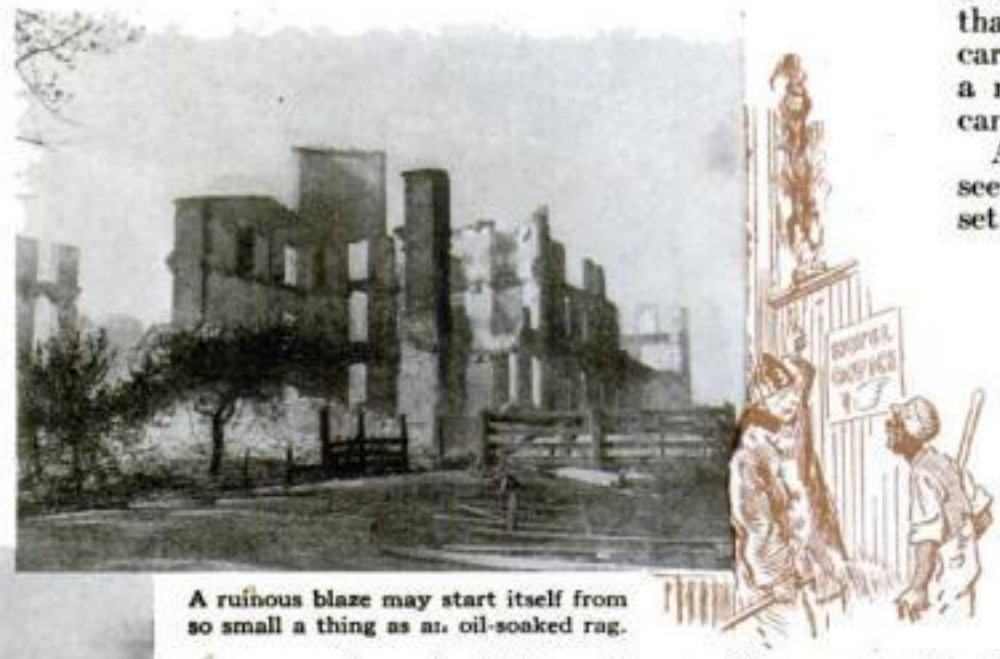
LATE one evening not long ago an excited voice came over the telephone wire to the Wichita, Kansas, fire department. "I've been smelling smoke for an hour," said the caller, "but I can't seem to trace where it's coming from." He gave the address of a Wichita hotel. In a few minutes the fire truck clanged up to the door.

Firemen found that the hotel office and a storeroom behind it were filled with the odor of scorching paint. Search led to a smoking cloth, saturated with the unmistakable odor of furniture polish, wadded up and left on the edge of a highly varnished partition. A hole was charred through it. So hot to the touch was the woodwork beneath it that in another moment it must surely have burst into flames.

Before he removed the cloth, the firemen's chief summoned all his men to see with their own eyes a typical case of spontaneous combustion— a fire that starts itself.

Next morning the porter, when told of his fault, was frankly incredulous. He didn't believe that a fire could start of its own accord. He would not be satisfied until he had taken another cloth, saturated it with the same polish, and put it in a safe place to see what would happen. In exactly one hour and twenty minutes it was a mass of flames.

Freak blazes have occurred from such a wide variety of sources that it is something of a task to say what will not cause a fire. Sunlight will; so will dust. Steam pipes have been rare but actual offenders. Nonelectric sparks from buzzing machinery—emery wheel sparks falling into inflammable material, for instance—and electric sparks from static electricity have produced a variety of queer fires equalled only by those that chemicals start. Liquefied glass and molten metal in factories have contributed their share. Bursting cylinders of compressed, inflammable gas have started fires.



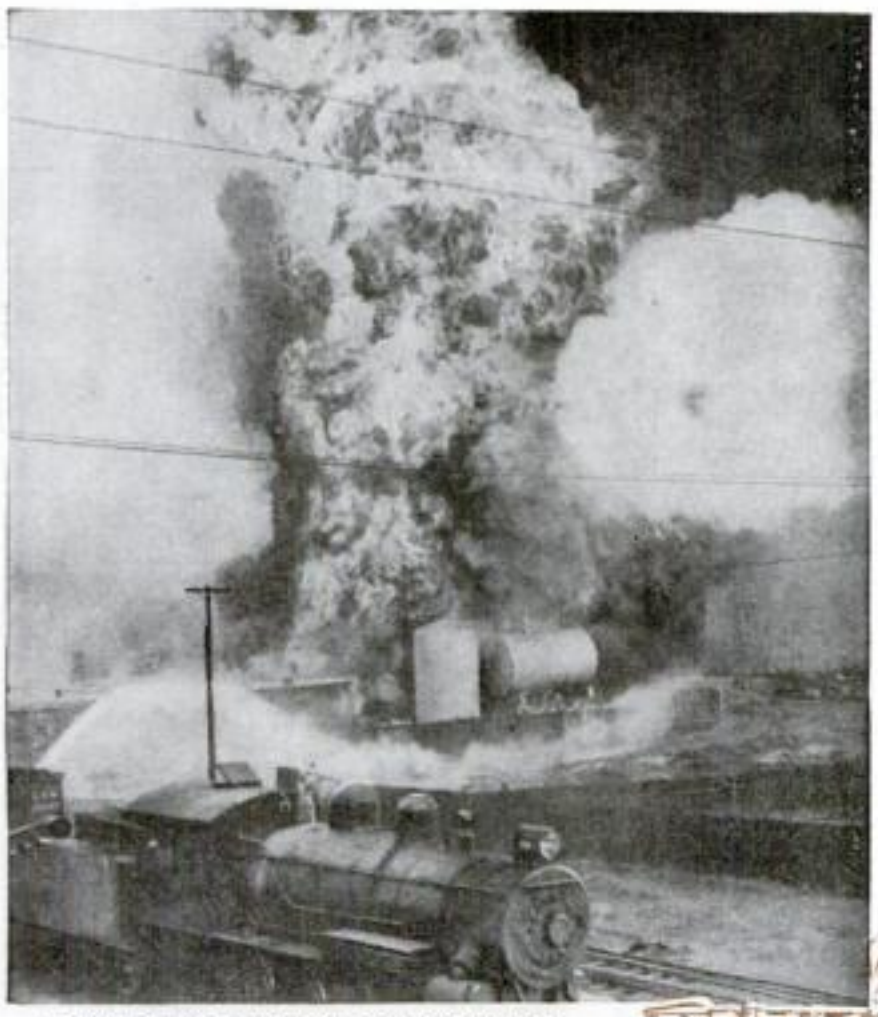
A ruinous blaze may start itself from so small a thing as an oil-soaked rag.

Strange fires in the wake of flood have been traced to heat generated in wet hay.

Perhaps the oddest of all involved a tombstone, a box of matches, and a freight car. For shipping, men had placed the granite block upright in a car. As the car passed over a switch the stone swayed and toppled. Fate decreed that it should alight upon a carton of parlor matches. Soon a merry blaze enveloped the car.

Almost unbelievable, it seems, that a steam pipe could set fire to woodwork. Nevertheless there are several well-authenticated cases of such blazes. When two teachers and 173 children perished in a fire that destroyed a Collinwood, Ohio, schoolhouse some time ago, that blaze was also believed to have originated where steam pipes passed through the floor. If the air space around them, required by law, is omitted, after months of baking the abutting wood becomes dried out and reduced to almost pure charcoal. Spontaneous combustion follows, and flames appear at stairway crevices.

Even an air bubble in a glass window pane can act as a miniature lens or burning glass, fire records show. Sunlight focused in that way on a celluloid comb or other inflammable article has contributed several cases of fire to the records. And the ornamental liquid-filled containers in drug store windows have been known to



Sparks of static electricity not infrequently result in terrific oil tank explosions and fires in gasoline tank trucks. Mere passage of gasoline through a filling station hose may produce enough static to ignite the tank.

Sunlight focused on a celluloid comb or other inflammable article, through an air-bubble lens in a window pane, has reduced many a home to ashes.

cause fires by acting as burning glasses.

Many a grass fire has started during a thunderstorm, along a barbed wire fence brushed by tall weeds, from stray sparks rather than direct lightning. As farmers know, the electric charge on a metal fence caused merely by lightning striking near by or by electricity in the air may be sufficient to kill livestock that touch it; and every spark is a potential fire menace.

There have been many odd chemical fires. A choice example occurred recently. In a women's hosiery mill in Durham, N. C., they were having trouble with their bleaching solution. Mill chemists could not trace the cause, and an outside expert was sent for. He arrived on one of the hottest days of the fall. Immediately he wanted to test the bleaching chemical—known as sodium peroxide—which was kept carefully, in small tin cans, in the dye house. It was guarded from moisture, because if water struck it a minor explosion would follow.

The expert carried a small quantity to the mill stock room where, surrounded by loose stockings on racks and scattered packing cases, he proceeded to weigh out samples. Beads of perspiration appeared on his brow. There was an ominous sputter as one or two fell upon the chemical he was weighing. Then the box burst into flame and exploded. Fragments of the sputtering chemical flew in every direction, and these exploded again. Particles bombarded the entire stock room, and each one burned a hole wherever it lit on a hanging stocking. A packing case, too, caught fire. Eight hundred dollars' worth of hose had been ruined before the flames were subdued.

Perhaps you have seen an alcohol type of pocket cigar lighter, in which the igniting element is not a flint but a tiny piece of sponge platinum that chemically lights the inflammable vapor. One of these, in an East Orange, N. J., drug store, gave one clerk an exciting day.

He prepared to refill the lighter from a stock bottle of alcohol; and, absent-mindedly, pulled off the platinum element and left it on the counter during the process. Of course the alcohol spilled, and a second later the vapor struck the platinum and flashed. Fortunately for the clerk, who dropped the bottle and ran, there was little alcohol in it at the time.

When a river near Augusta, Ga., overflowed its banks some time ago, it elected to inundate the basement of a store in that city that contained several barrels of unslaked lime. Soon the water-soaked lime was slaking merrily, giving off enormous quantities of heat. The fire that followed—a fire, oddly enough, that water started—burned down that building and several others. There are similar water-lime fires on record. One conflagration destroyed a large Connecticut tobacco barn. It remained a mystery until an investigator found traces of lime that had been soaked by rain beating in through the windows.

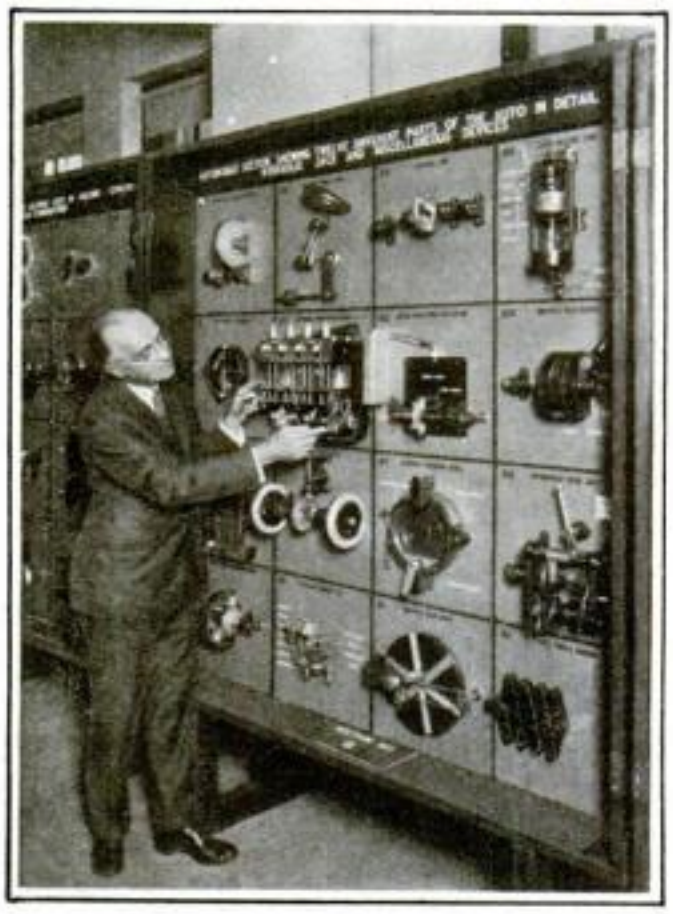
A minor fire became a serious one in a New York warehouse, not long ago, when firemen turned streams of water upon an insignificant blaze. The water, penetrat-

(Continued on page 145)

The housewife, cleaning gloves or other apparel in gasoline, may innocently set off a fatal blaze. The rubbing of the garment produces static which, in a leaping spark, ignites the explosive gasoline vapor.

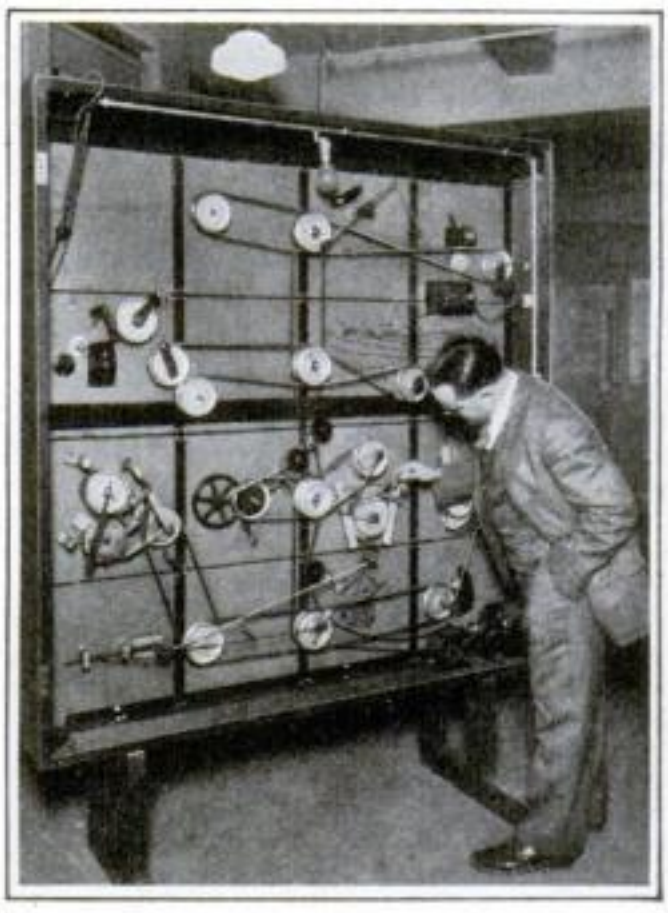
Strange to say, water can start fires. A flood near Atlanta, Ga., inundated a basement containing barrels of lime. The slaking of the lime produced heat enough to start a blaze, destroying several buildings.

A "Wonderland" of Model Machinery



ARE you familiar with the six simple, fundamental mechanical powers? Could you name them offhand — the lever, wedge, wheel and axle, pulley, screw, and inclined plane? And how many of their countless modern applications in the home and industry do you think you could list? As many as a hundred? Here is the story of a remarkable man who conceived and applied the idea of making us all better acquainted with the marvels of machinery.

Left: The designer and his wonder show. W. M. Clark explains miniature models of an automobile's parts.



Right: Rear view of the automotive section of the show, revealing the mechanism which operates the models, each of which is run by an electric motor.

AFTER years of ingenious labor, William M. Clark, a retired business man of South Orange, N. J., recently completed a unique collection of miniature models of most of the familiar mechanisms used in domestic life and industry today.

The models were designed to educate and inspire young people interested in modern mechanical contrivances and their history and development.

Mechanics is Clark's hobby. Denied the opportunity to follow a natural mechanical bent when a youth, Clark felt that there must be hundreds of young men throughout the country facing the danger of a similar frustration of their ambition. To reach as many of them as possible, he constructed his collection in such a way that it could be used as a traveling exhibition. The designer called his exhibit "Mechanical Wonderland," and took it "on the road." It was recently shown at the Museums of the Peaceful Arts in New York.

The exhibi on presents a clear bird's-eye view of most of the mechanical devices in common use, from simple pulleys to complex steam turbines and gasoline engines, all operated under power. It comprises 160 models, divided into ten sections, beginning with elemental mechanical forms and progressing to the most intricate machines.

The first five sections show pulleys, cams, ratchet movements, saw devices, foot-power devices, roller and ball bearings, belt drives, differential speed devices, and gear combinations.

The second part is devoted to machinery in domestic use. It also consists of five sections, demonstrating the operation of the doorbell, sewing machine, piano, furnace, plumbing, and various types of animal, wind, and man power devices.

Each section is contained in a boxlike frame which is hung on the wall of the exhibition room. Behind each section is an individual motor, operating from the lighting circuit. In this way, any section may be started or stopped independently.

Ingenious Paper Defeats the Check Forger

IN A laboratory at Rochester, N. Y., Burgess Smith, formerly in charge of the anticounterfeiting measures of the U. S. Bureau of Engraving and Printing, has been working for the last ten years to baffle check criminals that now exact an annual tribute of about $100,000,000 through check forgery and alteration.

Smith's first step was to discover an ink that would be made darker, instead of being bleached out, by the application of eradicating acid. This done, he devised a remarkable process of embodying in check paper a design which tells instantly when a check has been tampered with.

Standing beside a camera weighing three tons, and holding in his hand three glass plates, he explained the new process. On one of the plates the huge camera had photographed thousands of dots spelling hundreds of repetitions of the word "void." On each of the other two, an intricate dot pattern had been photographed by the same camera.

Smith placed the two latter plates on top of each other. A design of rosettes appeared. He shifted the top plate and the design changed to one of frost crystals. When the two plates were placed under the third one, the dots forming the "voids" combined with those on the other plates and became invisible. The rosettes or frost crystals remained.

The detector and its inventor. Chemically treated check papers are examined under light that is more intense than sunlight.

"The metal plates from which the check paper is printed are exact duplicates of these plates," Smith said, "and the one containing the words 'void' is printed in the special ink. The dots are arranged in accordance with a secret mathematical formula. By shifting the relative positions of the plates a fraction of an inch, we can get literally thousands of designs, all camouflaging the telltale words 'void.' The warning words are indistinguishable until eradicating acids are brought into contact with the paper. Then, the rest of the design fades out and the 'voids,' printed in the ink that it took so long to discover, leap from their hiding place."

One Man Could Run This Ship!

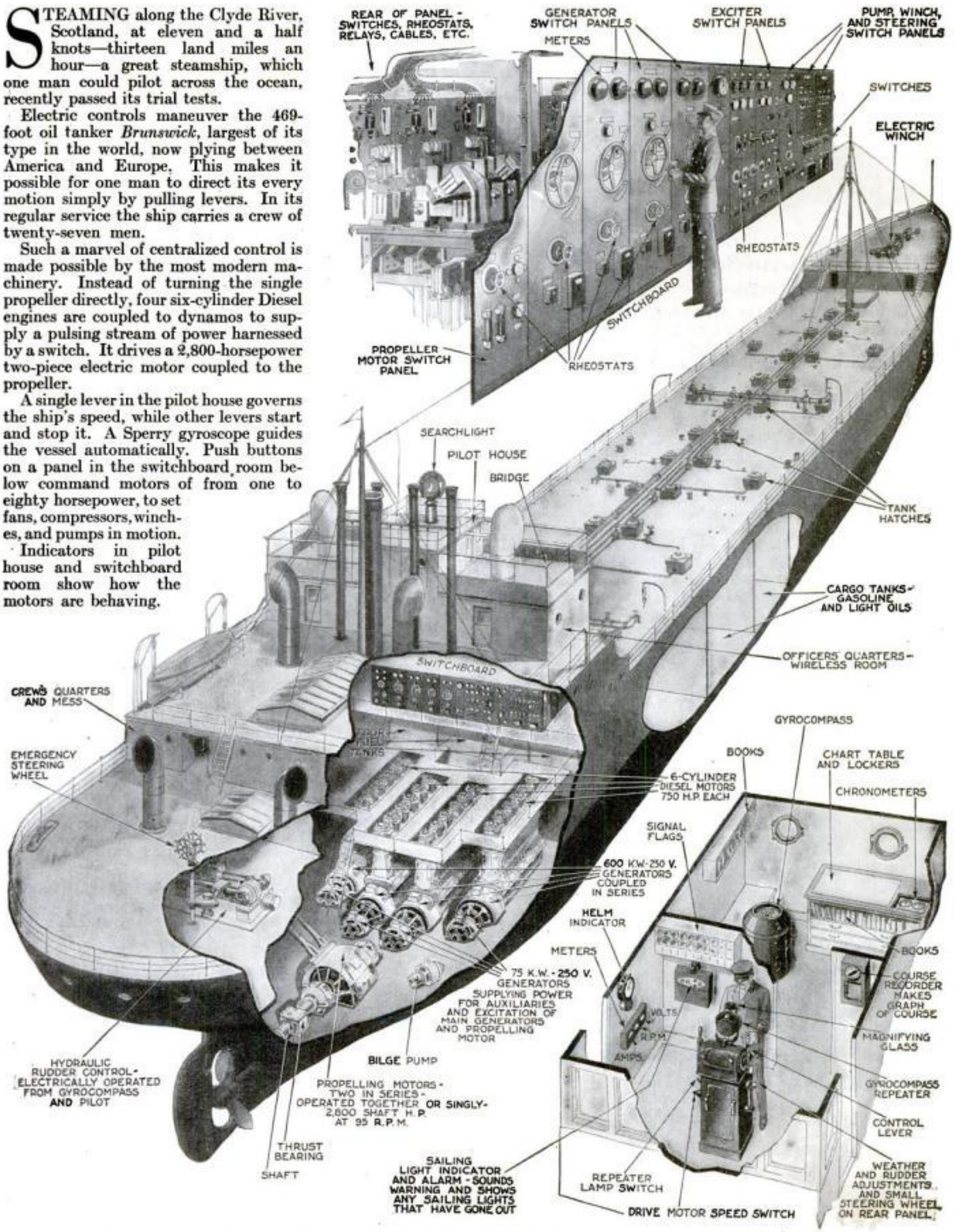
STEAMING along the Clyde River, Scotland, at eleven and a half knots—thirteen land miles an hour—a great steamship, which one man could pilot across the ocean, recently passed its trial tests.

Electric controls maneuver the 469-foot oil tanker *Brunswick*, largest of its type in the world, now plying between America and Europe. This makes it possible for one man to direct its every motion simply by pulling levers. In its regular service the ship carries a crew of twenty-seven men.

Such a marvel of centralized control is made possible by the most modern machinery. Instead of turning the single propeller directly, four six-cylinder Diesel engines are coupled to dynamos to supply a pulsing stream of power harnessed by a switch. It drives a 2,800-horsepower two-piece electric motor coupled to the propeller.

A single lever in the pilot house governs the ship's speed, while other levers start and stop it. A Sperry gyroscope guides the vessel automatically. Push buttons on a panel in the switchboard room below command motors of from one to eighty horsepower, to set fans, compressors, winches, and pumps in motion.

Indicators in pilot house and switchboard room show how the motors are behaving.



These broken-away views of the huge new oil tanker *Brunswick*, her switchboard room (top), and pilot house (right), reveal the improved electrical and mechanical features which give her remarkable simplicity of control and flexibility of operation. The ship's speed is governed by a single control lever in the pilot house, and all movements directed by levers and switches.

Hourglass, Germ Screen Added to Telephone

NEW equipment for the telephone, shown at an international invention exhibition, held recently in London, England, included a tiny hourglass for checking the time of a long-distance call, and a device for stretching paper over the mouthpiece of a telephone to prevent germs from entering.

The miniature "sand-glass" is attached to the side of the telephone in a holder which permits it to be removed and inverted each time it used.

The antiseptic paper, pulled from a small roll at the top of the mouthpiece, is torn off daily, or after each conversation. The thin sheet does not interfere with sound vibrations of the voice and is expected to provide an effective means of preventing the spread of disease by germs lodging in telephone mouthpieces. The date of the month, or advertising matter, can be printed upon this paper where it will be in a conspicuous position.

River Suddenly Vanishes for Three Miles

OVERNIGHT, three miles of a river in Colorado recently disappeared. One Friday night the White River, with its headwater at Trapper's Lake, east of Meeker, was flowing as usual. Saturday morning, part of the stream had vanished, leaving thousands of dead trout on the dry river bed. Examination showed that the river flowed into a hole in the ground and three miles further on issued from another hole in the side of a hill, continuing in its regular channel.

The theory is advanced that the stream cut into an underground passage or lake that provided an easier course.

Curious "Rubber Snake" Is Found in Yellowstone

THE first rubber snake ever found in Yellowstone Park was recently discovered by a party of visitors guided along one of the nature trails by a ranger who is also a naturalist.

A member of the family to which the boa and the python of the tropics belong, the rubber snake is a northern species and classed as a constrictor. The new inhabitant of Yellowstone, unlike its tropical cousins, is harmless. It is even claimed that it will make a faithful and affectionate pet, for those who like that sort of thing.

The recently found specimen was not more than a foot long and its body was of virtually the same diameter throughout, its tail being blunt like the head. The surface of the body was smooth, and its skin loose-fitting, of a greenish brown color above and a tannish yellow beneath. The maximum length attained by the rubber snake is about two feet.

Rat-Eating Rats Bred to War on Their Kind

A VARIANT of the old adage that "dog eats dog," to the effect that rat devours rat, is being put into practice at Leningrad, Russia.

To combat a veritable rat epidemic in the city, where it is estimated an army of 2,000,000 of the rodents are menacing public health and destroying approximately $2,500,000 worth of property annually, a system of self-extermination among the creatures is now in progress.

Rat-eating rats are bred by placing pairs of the animals in cages and starving them for a long time. In some cases, one of the pair will attack and eat the other under those conditions.

Then the rat-eating rats are paired until, by a process of elimination, a number of super rat-eating rats are evolved. With these ravenous beasts as the ancestors, breeding of cannibalistic rats is thereupon begun.

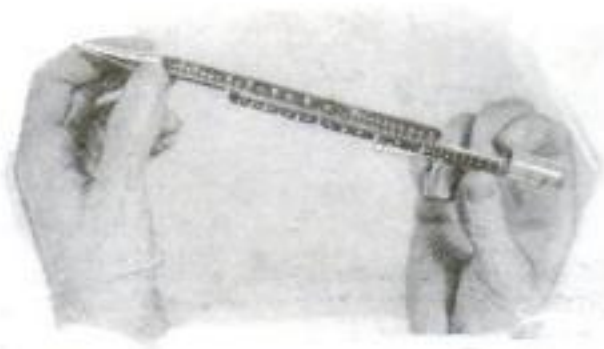
Centers of rat extermination have been established in 220 cooperative stores, ninety-six factories, ten storehouses, three markets, and thirty-eight other establishments.

In these places, the rat-eating rat will be let loose to attack his less carnivorous brethren and perhaps the results will be a ratless Leningrad.

A Pencil and Handy Slide Rule Combined

INSTEAD of chewing the end of a pencil when stumped by a problem in mathematics, the owner of a newly devised writing tool simply pulls on the end, and the pencil becomes a slide rule.

The pencil is refillable, the upper end carrying extra leads. An eraser and a pocket clip are part of the equipment.



Pencil and slide rule in one. The halves of the rule form the main body of the novel pencil.

Now Golfers Can Tee Off in the Living Room!

GOLF can be played in the house by means of a new toy which records the strength of drives and putts in yards, and shows the position of each player on a miniature golf course after every stroke. A "300-yard drive" can be made in a space no larger than is required to swing a golf club, the inventor says.

The game consists of two parts—a chart on which the course is pictured in miniature, and a recording dial with an arm, at the end of which the golf ball is attached. When a player strikes the ball the arm swings around the dial against a heavy coil spring, moving a pointer ahead of it. After every shot, the ball returns to its original position, but the pointer remains at the position on the dial which shows the force of the stroke in terms of yards.

The dial is marked off with a graduated scale up to 300 yards. After each stroke, a "marking ball" or counter is moved ahead on the charted "course" for a distance relatively corresponding to the "drive" recorded on the dial. The toy, says its maker, provides not only entertainment for the whole family, but aids the golfer to keep in form during the winter.

Fore! When the player "tees off," the strength of his drive is recorded on a dial in terms of yards, and scored on a miniature golf course.

Champion Blood Donor Has Given 117 Pints

A REMARKABLE record of blood-giving has been uncovered by the French Academy of Medicine. In three years, a thirty-year-old Frenchman, named Raymond Briez, gave 117 pints for transfusions and recently he submitted to his 264th operation for the purpose. The previous record for a year was held by a German who gave thirty pints. An American, with twenty-eight pints, was a close second.

Last year, Briez underwent four transfusion operations in twenty-six hours. His only ill effect was a temporary feeling of tiredness. In the case of poor patients, Briez always refuses to accept remuneration, although he often loses money as well as blood because he has to leave his work at the Paris Central Market to go to the hospital.

Complete Fire Department on a Two-Ton Truck

A ONE-MAN fire department, all on a single two-ton truck, has been built by Francis E. Ingals, of Guilford, Conn. It carries 1,000 feet of large hose in the body and 200 feet of smaller hose wound on a reel on the roof, as well as an assortment of nozzles and connections of various kinds. A 400-gallon pump is mounted on the truck; also a deck gun similar to those used on fire boats. The latter may be removed from the machine and used some distance away.

Searchlights on the top of the body are designed for floodlighting during night fires. A 110-volt generator and an engine within the body furnish current for the searchlights and also for an electric stove upon which hot coffee is prepared for fire-fighters in winter. Blankets, canvas covers, first-aid cabinets, hand extinguishers, thawing torches, and flares are stored away for emergencies.

This complete fire department was designed by the owner because he wanted additional protection for his country home. It is now used to fight fires which occur in the country outside the limits protected by the local fire department. It is the fifth apparatus of the sort which the designer has built.

The builder of the one-man fire department, Francis E. Ingals, at wheel of his elaborately equipped truck. Note deck gun and floodlights.

Door Hanging Simplified by Screwless Hinge

A DOOR hinge that requires no screws has been invented by Charles A. Genaux, of New York City, to save time and trouble in hanging doors.

Slanting holes are drilled into the edge of the door and into the hinge side of the door frame, slanting up in the door and down in the frame. Into these holes are inserted metal rods attached diagonally to the hinge, as shown at the right. All that is required to remove the door with such a hinge is a slight lift, which disengages the rods from the holes.

Million Mark Passed by Five U. S. Cities

FIVE American cities have a population of 1,000,000 or more, according to latest 1928 Census Bureau estimates. These five leading cities and their estimated populations are: New York, 6,917,500; Chicago, 3,157,400; Philadelphia, 2,064,200; Detroit, 1,378,000; and Cleveland, 1,010,300.

An interesting fact revealed by the estimate is that nearly every city in the 30,000 population class has grown since 1920. The report lists 262 American cities having 30,000 population in addition to those on the 1920 list.

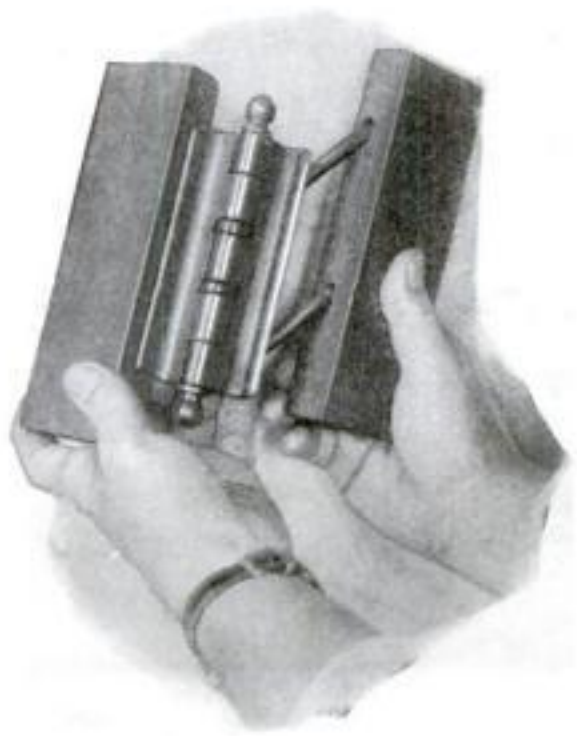
The cities which are estimated to have more than half a million population include: St. Louis, Baltimore, Boston, Pittsburgh, San Francisco, Buffalo, Washington, D.C., Milwaukee. No estimate is given for a number of cities, including Los Angeles, which had 576,673 in 1920, due to unusual conditions of growth.

Elaborate Model Railway Uses Tacks for Spikes

CARPET tacks are used for railroad spikes in an unusual model railway that occupies most of the front yard of an employee of the Southern Pacific living in Brookings, Ore. A town, a farming district, and a modern highway appear in miniature along the ninety-five feet of two-and-a-quarter-inch gage track over which two electric locomotives haul little trains which include tank cars, flat cars, gondolas loaded with lumber, refrigerator and box cars, stock cars, and cabooses.

Dolls are used to represent railway employees and citizens of the town, which has a school, church, store, hotel, and railway station.

Automobiles and trucks run along the highway and three airplanes are represented as flying over the town. The track has 120 rails, 882 ties which have been boiled in oil to insure long preservation, and 2,864 carpet-tack spikes. Over a small hollow in the yard, a six-foot trestle is supported by forty-five piles. The entire plot is landscaped with more than 350 miniature trees.



This model shows how the door, represented by block at the right, is hung on slanting rods.

Hand-Driven Buffer Wheel Polishes the Teeth

A TOOTH polisher, vest pocket size, is one of the ingenious devices shown at a recent exhibition of inventions held in London, England, at which nearly a hundred women inventors displayed models of new ideas. The polisher is operated by means of a plunger, which is pressed by the thumb as illustrated in the photograph. This action spins a rod, on the end of which is attached the polishing wheel.

According to the inventor, the device will permit any person to polish and whiten his own teeth at home.

Indians Had Tooth Ills 3,500 Years Ago

PYORRHEA was rampant among the Indians in New Mexico as long ago as 1,500 B.C., according to archeologists who have found very ancient skulls in the course of recent explorations in that state. The early red man, the discoveries showed, also suffered from cavities and abscesses.

Dental science is at a loss for an explanation of the prevalence of such disease in such an ancient race. The food of these earliest inhabitants of the American continent consisted chiefly of meat and grains, the same as ours. Cavities of large dimensions were found in unworn teeth, showing that they were not caused by the wearing down of the teeth through the use of coarse foods.

Studies of the teeth of ancient races, experts believe, may lead to new discoveries of the nature and causes of dental diseases, now only partly understood.

Telephone Calls Triple in European Cities

IN THREE years telephone calls between the nineteen most important cities of Europe have tripled. A record of such calls shows that three people use the phone today where one used it in 1925.

This rapid growth of service in European centers of population is viewed as an aid to communication between continents. The increase in good connections in European countries advances the value of the trans-Atlantic lines that connect Great Britain, France, Germany, Belgium, and Sweden with the United States, Canada, and Cuba.

Philippines Will Witness Sun's Total Eclipse

IF YOU are interested in total eclipses of the sun, you might do well to plan to be in Manila, P. I., on May 9, 1929, when that phenomenon will occur there.

The Hamburg, Germany, Observatory already has made preparations to send a party, and it is expected that several groups from other parts of Europe and also from the United States will follow.

According to Father Miguel Selga, S.J., director of the Philippine Weather Bureau and the Manila Observatory, two factors will warrant the time and expense involved in observing the eclipse—first, the probability of clear weather, and second, the duration of the eclipse over accessible and convenient points.

The plane of total eclipse extends across the middle islands of the Philippines, the Visayan group, and through the tenth and two thirds of the eleventh degrees of north latitude. The duration of the eclipse over this area will be three minutes fifty-four and a half seconds.

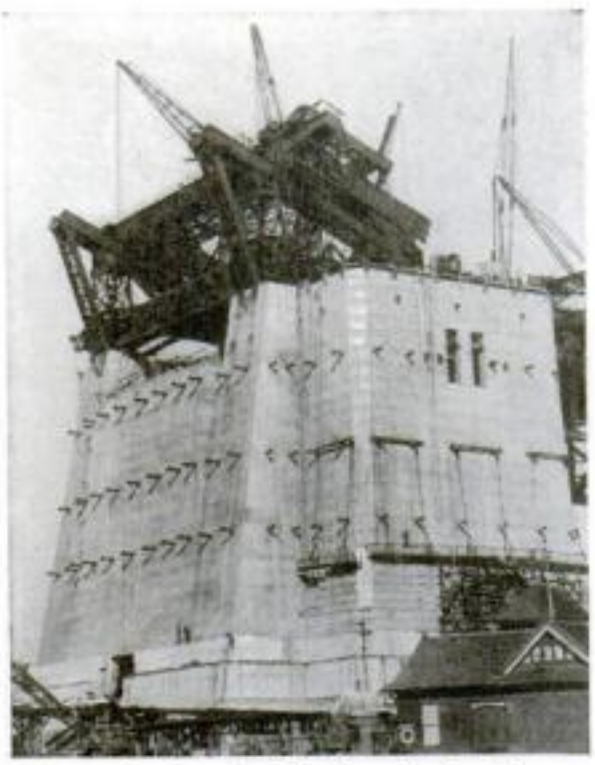
There will be places in Siam and on the island of Sumatra where the eclipse also may be observed, but the Philippines will be the logical spot for American observers.

California Fishing Fleet Gets $13,000,000 Haul

LARGELY through the use of scientific methods, Los Angeles fishermen made a $13,000,000 catch last year. Most of the haul, taken from the waters off southern California, consisted of sardines and tuna. Some of the vessels were equipped with Diesel engines and refrigeration, and could cruise for hundreds of miles without putting into port. Of the sardines caught, seventy-five per-cent were canned and the remainder were run through a fertilizer plant and converted into fish meal, which is used both as fertilizer and as food for livestock.

Huge Pylons to Support Greatest Arch Bridge

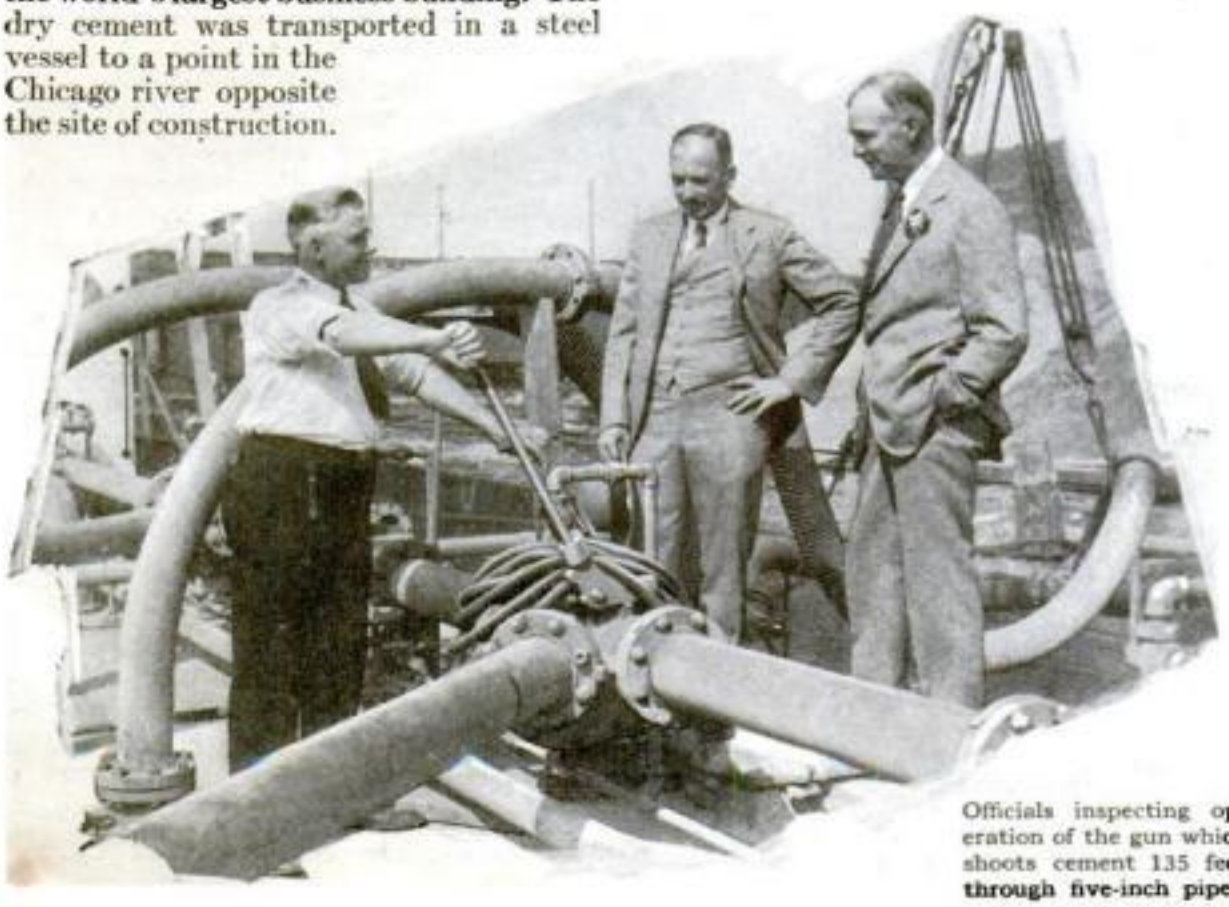
FROM towering pylons of masonry that would bear the entire weight of the steamship *Leviathan* without crumbling, the world's greatest arch bridge, with a central span 1,650 feet long, is being built across Sydney Harbor, Australia. The photograph below shows the main pylon, on the city side of the harbor. On its summit creeper cranes are being prepared for the task of swinging ponderous steel beams into place over the harbor.



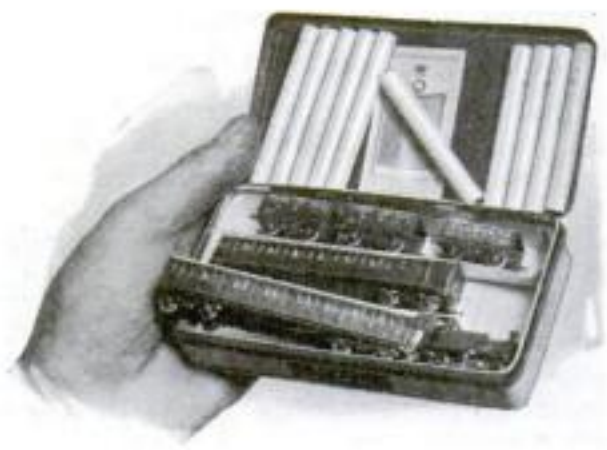
The main pylon of the bridge, showing huge cranes ready to swing steel beams into place.

Air Pressure Gun Shoots Cement 135 Feet

TWO million pounds of cement were shot through five-inch hose seventy-five feet into the air recently when work began on the foundations for the Merchandise Mart in Chicago, designed to be the world's largest business building. The dry cement was transported in a steel vessel to a point in the Chicago river opposite the site of construction. There a compressed air gun shot the contents of the hoppers in the ship's hold through a hundred and thirty-five feet of pipe and seventy-five feet high into a huge three-story bin on shore.



Officials inspecting operation of the gun which shoots cement 135 feet through five-inch pipes.



Working Model Train Fits in Cigarette Case

A MODEL train, built to scale and operated by an electric motor housed in the tiny engine, is carried around in a cigarette case by the English enthusiast who constructed it. It was built by J. Langridge, of the Wimbledon and District Model Railway Club, and shown at a recent model engineering exhibition.

It is believed to be the smallest working scale model railway train in the world. In every detail it was constructed at a scale ratio of eight hundredths of an inch to a foot. At its tallest point, the cab of the locomotive, the miniature train is only half an inch high and the track it runs upon is three-eighths-inch gage.

The tiny train, with its engine, three coal cars, and two passenger coaches, fits snugly into one side of a cigarette tin designed to hold fifty cigarettes.

Fresh Air One Mile Down

A MILE below the earth's surface, miners working in the copper mines of the Lake Superior region are supplied with abundant fan-driven fresh air through canvas tubing from the mine openings. A recent survey showed that from 40,000 to 100,000 cubic feet of air per minute was circulating through the lower levels of the shaft. Here the rock temperature was ninety degrees F.

How Much Do You Know About the Weather?

TEST your knowledge with these questions, chosen from hundreds asked by readers. Correct answers are on page 158.

1. How high are the clouds?
2. What is the difference between a hurricane, a cyclone, and a tornado?
3. What causes frost?
4. What causes a red sky at sunset?
5. What causes rain?
6. What is a rainbow?
7. What is the meaning of the lines on a weather map?
8. What does a barometer tell about the weather?
9. What causes the rings around the moon?
10. What is a hygrometer?

It Plays a Tune When You Light a Cigarette

WHEN you lift the lighter of an unusual smoking set recently placed upon the market, a music box concealed in its base plays a tune. The set, consisting of a lighter, a container for cigarettes, and an ash tray, forms a compact accessory for the smoker which, says its inventor, will provide entertainment each time a cigarette is lighted.

Timing Wind Speed a Hard Job for Weatherman

HOLDING a stopwatch on the wind is the most difficult job of the U. S. Weather Bureau, according to its chief, Prof. Charles F. Marvin. An improved anemometer, or wind-measuring instrument, consisting of four wind-driven cups mounted on revolving cross arms, has proved an advance over previous instruments of the kind, which lagged in winds up to ten miles an hour, and then progressively recorded speeds above the actual rate for winds beyond fifteen or twenty miles an hour.

The new instrument gives correct readings for high velocities. However, there remains the problem of standardizing the conditions under which records are made in different localities. The roofs of buildings where the readings are made are sometimes high and sometimes low; sometimes they are sheltered by taller buildings and sometimes they are unobstructed on all sides. Before accurate wind records for the whole country can be made, all instruments must be placed at the same height above the ground under similar conditions, Professor Marvin believes.

Know Your Car

IN ANY automobile engine except the sleeve valve type, the valves are operated by push-rods moved up and down by the cams on the cam shaft. These valves must open and close at precisely the right time if the motor is to deliver full power. There must be some play or looseness in the mechanism to allow for the expansion and contraction of the parts caused by the heating and cooling of the engine. The designer takes this play into account when he figures the contour of the cams.

If the valve adjustments are set too loose the motor will lose power and be noisy. If set too tight, power will be lost, and in addition the valves will not seat properly and will become burned.

New Airway Beacon Weighs Nearly a Ton

A FINGER of light miles long penetrates the darkness from a new million-candlepower beacon light designed to guide night flyers along the airways. It is called the largest portable beacon ever built. Its diameter is five feet and its total weight almost a ton.

It can be tilted up or down, rotated sideways, or transported from place to place on the carriage it is mounted on.

The mammoth portable searchlight, of a million candlepower, on exhibition in Chicago.

Tigers and Men Fight to a Draw in India

MEN with rifles and tigers with claws fought virtually an even battle in India last year, according to statistics of the number of tigers killed by hunters and the number of persons killed by tigers, recently issued by the Indian government. One thousand and thirty-three persons were slain by the beasts while 1,368 tigers were shot or trapped during the twelve months, making a ratio of almost one man for every tiger.

During the same period, leopards killed 218 persons, while men retaliated by taking a toll of 4,390 leopards. Snakes are still the greatest danger in India. In 1927, 19,069 people died of snake bite. The estimated number of snakes that died at the hand of man during the same period is 57,116. Other beasts listed, and their human toll, are: crocodiles, 136; wild boars, 85, and elephants, 56.

Yellow and Red Rays Also Vital to Body Growth

ALL the colored rays of sunlight and not merely the invisible ultra-violet, or "health" rays, are needed to make your body grow.

That is the conclusion of Dr. Charles Sheard, of the Mayo Clinic, Rochester, Minn., who tried raising two broods of chickens, one in light from which colored window panes removed the red and yellow rays only, and the other in light with the green and blue rays removed. In both broods the overworked parathyroid glands, which have an important part in converting food into tissue and energy, became abnormally enlarged in an effort to make up the deficiency. Cod liver oil in small doses remedied the trouble.

Remarkable Model Shows Apartment Village

HOMES at cost for 625 families will be provided when a mammoth, block-square group of modern apartment houses sponsored by Marshall Field, is completed in Chicago. A model of the project, recently exhibited there, shows the ten units, which will make up the project, with air spaces between each for light and ventilation. Each of the units will house about sixty families apiece, providing them with every modern convenience, and will be rented to the occupants at cost.

The model, built precisely to scale and complete in every detail, is a striking example of latest methods in architecture, described in last month's issue, which enable a prospective owner, before construction work begins, to see exactly how the completed building will appear.

This scientific scale model of the projected block of modern apartment houses for Chicago gives a better idea than any maps or drawings of how the dwellings will appear when they are completed.

Hailstones Larger Than Baseballs on Record

HOW big do hailstones grow? To answer this frequently-asked question, the U. S. Weather Bureau has listed some of the historic hailstorms of the past. In 1847, hailstones that measured fourteen inches in circumference are said to have fallen in New South Wales. Others, weighing four and a half pounds, were reported after a storm at Cazorla, Spain, in June, 1829.

Thousands of bombarding balls of ice, each as large or larger than a big-league baseball, fell at Dallas, Texas, a couple of years ago, causing nearly half a million dollars damage. The most amazing report of such a bombardment from the sky came from Cette, France. Here, in October 1844, such huge hailstones are said to have fallen that they wrecked dwellings and sank vessels anchored off shore.

The formation of large hailstones begins at heights estimated at between 15,000 and 40,000 feet above the ground.

Pocket Microscope Looks Like Fountain Pen

SLIP off the cap of this little black instrument that resembles a fountain pen, and you have a powerful pocket microscope ready for action. A sliding button on the barrel focuses a surprisingly strong lens, and a tiny mirror in the base supplies illumination from any near-by lamp or window. All that is necessary is to rest the point against a document or object to be examined and focus the lens, and you can see the object magnified many times in the eyepiece. The sliding barrel adjusts the power of magnification.

Plants, Like People, Tanned by Invisible Rays

PLANTS, as well as people, get tanned from exposure to ultra-violet rays! Thus reports Dr. E. M. Delf, secretary for a committee of English botanists who are carrying on experiments with plants to determine just how they are affected by the invisible rays that sunburn the exposed necks and arms of human bathers at the seashore.

When a plant was exposed to the glare of a quartz mercury vapor arc, recently, the surface of the plant turned brown. An examination of the "sunburned" plant with a microscope revealed that the change in color had been caused by a breakdown of the outer layer of cells.

New Army "Whippet" Tanks Built for Speed

Wallowing in mud, two of the speedy new "whippet" tanks are about to ford a stream.

ARMY tanks that dash over the ground at a speed only slightly below that made by Charlie Paddock when he set the world's record for the hundred-yard dash have been successfully tested at Fort Leonard Wood, near Baltimore, Md. On level ground, the new tanks rumble along at a twenty-mile-an-hour clip. For splashing through mud, fording streams, or traversing rough country these "whippet" tanks are equipped with a new type of tread which is said to grip the ground more effectively and to increase speed. Extensive tests of an experimental model, covering 1,500 miles, showed that it could climb hills that ascended at an angle of forty-five degrees and could carry sufficient gasoline for an eighty-mile run. A novel feature is that the tank is built on an all-purpose chassis on which can be mounted several different styles of body.

The machine is especially designed to carry one man and a machine gun over shell-swept territory with the greatest possible protection. To this end it is built with a low body to offer the least target for enemy fire.

Tower Thermometer the World's Largest

WHEN citizens of Munich, Germany, want to see how cold it is, they can poke their heads out of doors and look at what is said to be the world's largest thermometer on the tower of a museum in that city.

The huge instrument, which can be seen for miles, occupies nearly the whole side of the tower. It was built by a Berlin engineer, Paul Fuess. In spite of its great size, the thermometer is said to record the temperature accurately. Above the thermometer is located a proportionally-large barometer, resembling a huge tower clock.

Comparison with the tiny figure of a man standing at the foot of the thermometer gives an idea of the instrument's bigness.

Exercise After Meals Not Harmful, Tests Show

UPSETTING the old belief that exercise after meals is harmful, three physicians who have made a series of tests at Guy's Hospital, in London, England, report that moderate exercise taken immediately after eating does not retard, and may even aid, digestion. As long as the exercise does not make you uncomfortable, they found, it does not disturb digestion.

Men in training were found capable of running two miles slowly after a meal without injurious effects. Men not in training, however, found that an hour's walk was sufficient to hinder digestion. Violent exercise after a meal, say the doctors, results in temporary anemia, or lack of blood, in the stomach, due to the amount that is drawn away to the muscles which are being exercised.

Record Blast Displaces 40,000 Tons of Rock

A SINGLE blast in a Welsh limestone quarry recently displaced stone weighing 40,000 tons from a cliff 100 feet high. It is said to have been the largest limestone quarry blast ever set off in the British Isles. Three and a half tons of high explosives were used in the charge.

Three months had been spent in preparing for the big explosion by sinking sixteen shafts, with an average depth of 110 feet, to contain the explosives, which were set off electrically. The explosion stripped the rock from the cliff and left a smooth surface for future quarrying operations.

Newest Locomotive "Cart before the Horse"

Two sets of drivewheels, on separate trucks, enable the huge locomotive to round sharp curves.

LONGER freight trains will climb the winding Rocky Mountain tracks when huge freight locomotives of the newest oil-burning type, constructed in the shops of the Southern Pacific Railroad, in Sacramento, Calif., are put into operation. The design of these great locomotives is revolutionary. Reversing the usual practice, the engineer's cab is in front and the stack in the rear, making the locomotive appear as if running backward. In addition, the long, rigid body really embodies two separate engines on separate trucks, each operating its own set of driving wheels beneath. This feature of "articulation" increases the locomotive's flexibility and enables it to swing about sharp curves that an ordinary engine the same length would have difficulty in managing.

The hardest part of the run over the Southern Pacific line from Sacramento to Sparks, Nev., will be taken over by the new engines. Their water capacity is 12,000 gallons, as compared with the 9,800 gallons in the locomotives used previously on this run, and the oil capacity is increased from 3,112 to 3,771 gallons.

Another fleet of articulated oil-burning mountain-climbers is being built by the Great Northern Railway at a cost of $110,000 each. They will pull 100-car freight trains over mountain divisions.

Giant Pump Is Lubricated With Water It Lifts

A SIXTY - THOUSAND - POUND pump that lubricates its bearings with water has been installed at an irrigation well near Etiwanda, in southern California. The giant pump lifts water 640 feet, in a single boost, from the bottom of a 450-foot well to the top of a hill where irrigation ditches carry it away. It is believed to be the highest pressure turbine pump ever built.

An electric motor of 350 horsepower furnishes the power. Because frequent trouble in oil lubricated pumps has resulted from clogged oil lines and burned-out bearings, the makers of the Etiwanda equipment had been experimenting for some time with pumps that lubricate themselves with part of the water they raise. In preliminary experiments with small six-inch pumps, similar to the one shown at the left of the photograph, water lubrication proved satisfactory. Subsequent tests of the new thirty-ton pump gave convincing proof that bearings of large size also can be kept in good working condition with nothing but water for a lubricant.

It had been predicted that sand in the water would cause rapid cutting of the bearings, but it was found that the unique design of the bearings of the new pump eliminated most of this danger, and that any sand that crept into them was washed out before it could cause abrasion.

Millions of Tons of War Explosives Put To Use

HOW T.N.T., made for destructive war purposes, ended by becoming an aid to industry and agriculture, is told in a recent report of the Explosives Division of the Bureau of Mines.

The war ended with 126,000,000 pounds of high explosives on hand in the United States. All of this dangerous supply has been used for blasting and irrigating. Before the war, T.N.T. had been considered unfit for industrial purposes. The Bureau of Mines carried on experiments and instructed users in the best methods of handling the powerful explosive.

The excellent keeping qualities of T.N.T. were demonstrated recently when a store nearly ten years old was examined and found to be fit for use in blasting.

New thirty-ton irrigation pump, lubricated with water. Compare its huge size with those of the man and the six-inch pump at the left.

Modern Machines Develop Rich Diamond Field

THE long monopoly on diamonds which the South African fields have enjoyed is being threatened by the increasing output of the Belgian Congo mines. From a total output of 15,000 carats, in 1913, the production of the Kasai district, the principal Belgian Congo field, has risen to more than 1,000,000 carats. This represents one fifth of the total world production.

The sudden increase in output is due to the use of improved machinery and equipment. The pick and other primitive implements have been superseded by mechanical excavators and washing machines of the latest type. A seventy-mile narrow-gage railway and 4,000 miles of new road have been constructed. The result of the mechanizing of the mines is seen in the present enormous production.

The diamonds mined here are not as large, however, as those of the famous Kimberley fields to the south. The Kimberley mines still produce the biggest diamonds in the world. One dug there recently is said to have weighed 412 carats and was sold at the mine for $25,000. When it is cut, its value is expected to be at least $50,000.

Sandpapering Made Easier by Handy Holder

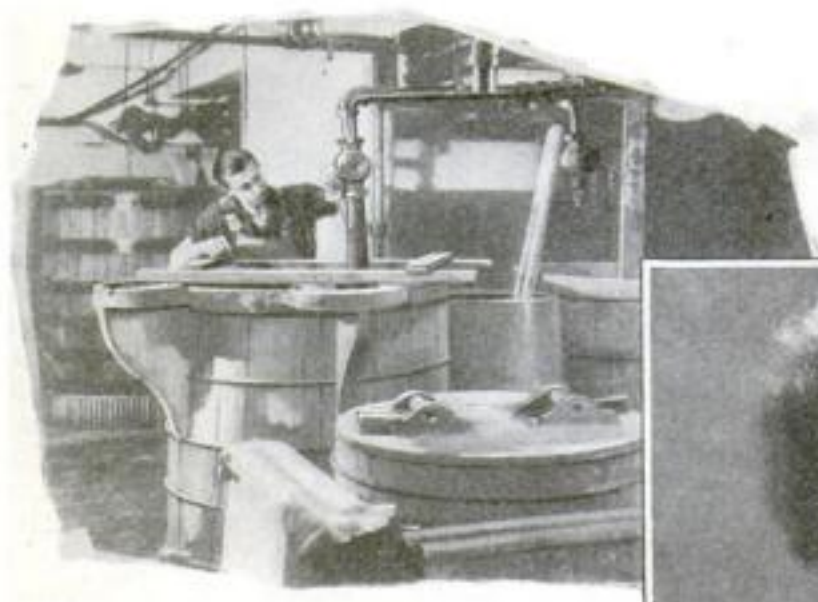
A NOVEL means for holding sandpaper, emery, or other abrading material for handwork is provided by this newly devised block. On both sides of the block are slots into which the ends of the polishing material are inserted. Special clamps are then pressed in as shown in the photograph, holding the material firmly in place. Having one sharp and one round edge, the sander is adapted to any shape of molding. A rounded handgrip makes it easy to hold.

With a polishing cloth firmly stretched over the block, photographers find it useful for polishing ferrotype plates. With a cloth dipped in paraffin, the housewife may use it as a flatiron polisher, which is one of its many uses about the home.

For polishing moldings, pipes, or large round surfaces, another block is supplied with a concave surface.

Begin Search for Radium

CARNEGIE INSTITUTION, Washington, D. C., is to conduct a world-wide search for radium. In the whole world there has been mined less than four ounces of this valuable substance. Most of it has been found in Colorado, although some has been discovered in Russia and some in Turkestan.



With a five-pound chunk of silver at her finger tips, no wonder Doris Hill, movie actress, smiles. It was salvaged from the film fixing vats at the left.

Silver Nuggets Salvaged from Movie Films

MINING silver from the silver screen is the latest source of wealth in Hollywood. From the miles of film that run through the fixing bath in the developing rooms, the hypo takes infinitesimal particles of the silver that forms part of the sensitive outer coating of the film. The amount from a single film is slight, but at the end of a day the silver sediment has accumulated in the bottom of the fixing vats in surprising quantities.

In recent tests of a new chemical process for reclaiming this silver a five-pound piece of silver, shown in the photograph at the right, was obtained. The large hypo vats of a west coast studio, shown above, give an idea of the size of the fixing baths which have become "silver mines," thanks to the ingenuity of chemists in salvaging precious metal previously thrown away. Science is continually discovering new ways in which to reclaim the waste products of industry.

Patrolman's Club Also Flashlight

A POLICEMAN'S night stick that provides a bludgeon at one end and a flashlight at the other has been devised to aid officers when they patrol the dark alleys. The stick is made of steel tubing with threads in the end of the grip, into which a flash lamp is screwed. This arrangement, the inventor says, enables an officer on night duty to throw out a beam of light without waiting to pull a flashlight from his pocket, at the same time permitting him to keep the club in his hand ready for use. Tucked under the arm with the light directed on a notebook, it leaves both hands free for writing.

Flashlight batteries are contained in the grip, and are replaced simply by removing the lamp bulb.

Pressing a button on the grip of the policeman's night stick turns on the flash lamp.

Predicts Water in Place of Coal for Fuel

THE future fuel will be water instead of coal, according to Dr. Walter von Hohenau, a Brazilian physicist, who says he has discovered a means of liberating the hydrogen from water. His process, he explains, is the result of years of research. By applying very high frequency vibrations to water, he says he has been able to break it up into its constituent elements of hydrogen and oxygen. The hydrogen, he contends, will be used in place of coal gas as a fuel and will make the mining of coal unnecessary.

When Dr. von Hohenau presented his plan at a recent world fuel conference, held in London, the objection was raised by a member of the conference that the energy required to set up the vibrations, even if they were capable of liberating the hydrogen, would offset the energy gained by its use.

Coconuts May Rival Cows

COWS and coconuts will become rivals if tests of a new chemical process for making a milk substitute from the fluid in coconuts proves commercially valuable. The meat of the coconut is being used in many ways, but few uses have been discovered for the "milk" within the shell. In Manila, where great factories shred the meat of the fresh nuts, the fluid has little commercial value.

Herbert Walker, an American chemist, has just applied for a patent upon a process which he says will produce a genuine milk from this fluid by blending it with the liquid from the pressed fresh meat. The result is said to be a rich and wholesome beverage applicable in every way in which milk is used. The resemblance is said to be so close that cream rises to the top; and, when fresh, it foams in the same manner as does real milk from the cow.

Simple Ways to Measure the Speed of the Wind

A SIMPLE guide for judging wind speeds has been worked out by the Forest Section of the U. S. Department of Agriculture. In forest fires, the number of men needed on the fighting line is often in direct proportion to the strength of the wind that is blowing. To help men in the field, who have no instruments to measure the speed of the wind, these rules, which anybody can follow, are given by experts of the Service:

A light wind, up to seven miles an hour, is felt lightly on the face, and rustles leaves.

A gentle breeze, eight to twelve miles an hour, keeps leaves and small twigs in constant motion and lifts a light flag.

Moderate winds, thirteen to eighteen miles an hour, raise dust and sway small branches.

Fresh winds, nineteen to twenty-four miles an hour, sway small trees in leaf and cause crested wavelets to form on inland waters.

Strong winds, twenty-five to thirty-eight miles an hour, whistle through telephone or telegraph wires. One walking against them feels himself being held back.

A gale, thirty-nine to fifty-four miles an hour, breaks twigs off trees and often inflicts slight structural damage to buildings.

A whole gale, fifty-five to seventy-five miles an hour, uproots trees. Any wind with a velocity of more than seventy-five miles an hour is classed as a hurricane.

This Mail Box Sheds the Water Like a Duck

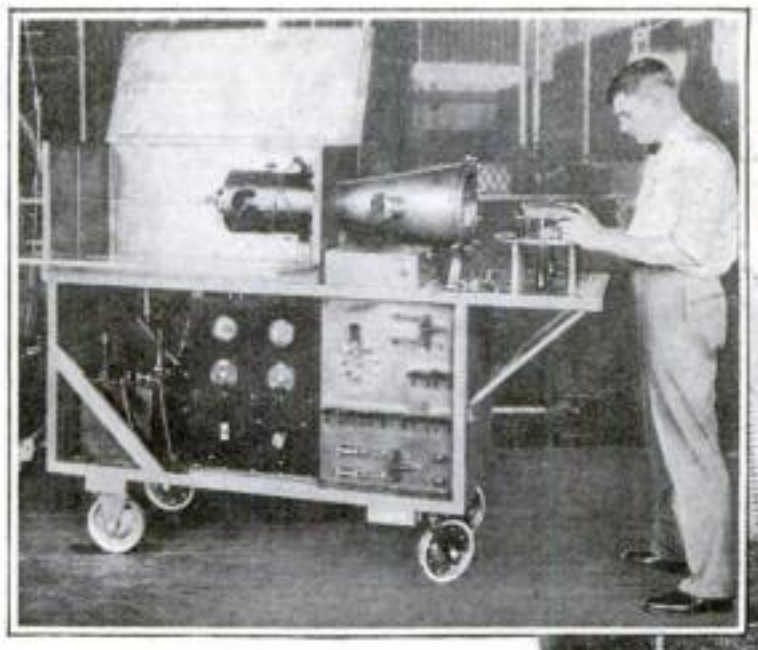
THE proverbial duck's back is gone one better by the mail box invented by L. A. Stelhouse, of Baltimore, Md., which sheds most of the rain from its top and directs what little enters by way of the letter slot out through an opening, so the moisture never reaches the letters deposited within.

When mail is deposited in the slot, a metal grill at the top directs it at an angle into the main compartment of the box beyond a partition. This partition catches the rain that drops from above into the slot and directs it out the back.

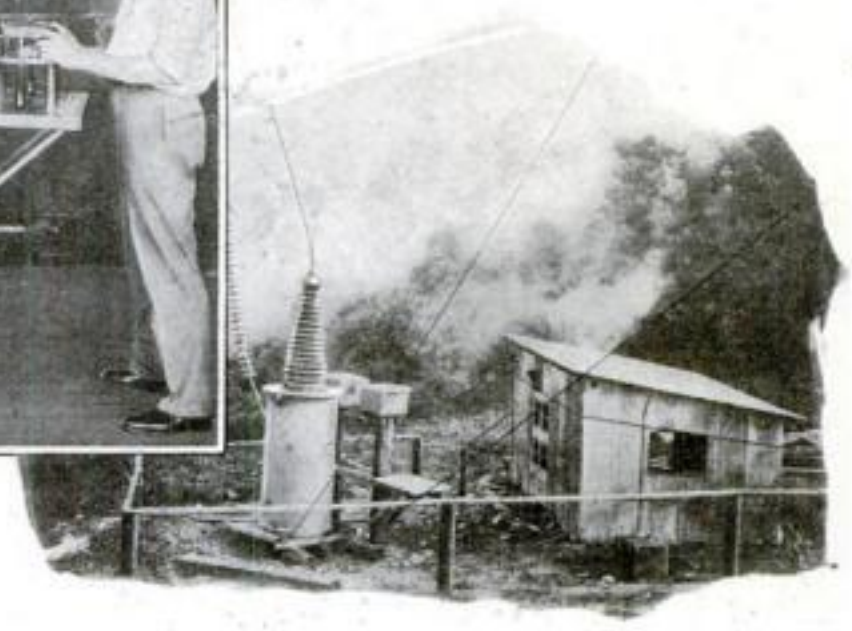
The inventor pours water into the slot of his new mail box to show that it is rain-proof.

Camera Records Path of Lightning Bolt

FOR the first time in history, the flashing progress of a natural lightning bolt on its way to the ground has been recorded in a close-up photograph. The feat was accomplished recently near Lake Wallenpaupack, Pa., by a marvelously high-speed camera, otherwise known as an automatic cathode ray oscillograph. This instrument, somewhat similar to one described in the article "New Magic Worked by Cameras" in the September issue of POPULAR SCIENCE MONTHLY, was developed in the engineering laboratory of the General Electric Company. It records what goes on in incredibly small intervals of ten millionths of a second.



Left: High-speed camera, known as cathode ray oscillograph, which made first photographic record of a lightning stroke. Below: Lightning-proof steel laboratory where photo was made.



At Wallenpaupack, the camera photographed the progress of a lightning bolt as it struck a high-voltage power transmission line. The time which elapsed from the striking of the bolt until the electric pressure of the impact reached 1,500,000 volts was revealed to be five millionths of a second! In another split second the voltage reached 2,500,000 and in another ten millionths of a second it began to drop. From the impact until all effects of the bolt vanished from the camera's eye, forty millionths of a second elapsed.

This camera is more than a laboratory plaything. It is being employed to study the nature of lightning and its effects on high-tension power lines.

Invents New Television System Minus Disks

SOME television experts believe that while apparatus like spinning disks and synchronized motors are necessary today, television transmitting and receiving sets of tomorrow will have no moving parts. Working along this line, Philo T. Farnsworth, of Provo, Utah, has devised what he claims to be a television projector which employs no whirling scanning disk. The receiving screen, he says, is the coated fluorescent bottom of a glass flask, and the scanning beam that paints the picture is a beam, not of light, but of cathode rays swung across it by stationary magnets. He claims his invention can transmit twenty pictures a second.

The inventor with his new television apparatus. Glass object in his right hand contains the receiving screen.

Another improved apparatus, devised by Dr. E. F. W. Alexanderson, one of television's pioneers, exhibits a moving image twelve inches square, as compared with the three-inch pictures previously obtained. It uses a spinning scanning disk studded with lenses.

Tests of Lumber Reveal Why Paint Fails

WOOD has holes in it, and paint catches in them. If it can find plenty of good-sized holes or pores in the wood to enter, the paint will stick. Otherwise it will drop off in flakes. There is no inherent stick-to-it-iveness about paint.

That is the conclusion of the Forest Products Laboratory, U. S. Forest Service, after careful tests to find out why paint fails. It found that paint adheres readily to spring growths of wood, and poorly to summer growths, because the former are porous and the latter dense and comparatively poreless. The different behavior of the two kinds of wood shows up sharply when a board containing both is painted, as illustrated in the accompanying photograph.

Dark streaks show bands of summer wood on which paint has failed. Light portion is spring wood on which the paint sticks.

Before paint will stick to all boards with equal durability, some method must be found, the Laboratory concludes, to make it adhere even to wood with a shortage of large pores.

Toy Sails 1,750 Miles

DURING a recent celebration, Thomas J. Rubino, of Paterson, N. J., sent up a toy balloon with a note attached asking the finder to communicate with him. He received a letter from a man in Albuquerque, N. M., 1,750 miles away, saying the balloon had been found on his roof.

U. S. Experts Seek Paper That Won't Wear Out

PAPER that won't wear out is being sought by the United States Bureau of Standards in Washington, D. C. As a first step in this direction, experts of the Bureau are testing the different products that are now on the market. These will be put through accelerated aging experiments in the laboratory by the use of artificial heat and light.

Chemical and physical tests will follow to determine the constituents of the various papers and their effect upon its wearing quality. Later, the Bureau will coöperate with manufacturers to increase the durability of their product.

An interested observer of these tests is the American Library Association, which has been seeking more durable new material for book leaves. Special newspapers for bound volumes, printed upon a newsprint paper of rag fibers said to be of remarkable durability, have appeared recently in an effort to lengthen the life of dailies preserved in libraries.

Deepest Oil Well Goes Down 7,800 Feet

A TUBE of steel, driven 7,800 feet into the earth, is now bringing oil to the surface from what is believed to be the deepest producing well in the world, in the Signal Hill oil field in southern California. Experts believe that the success of this new well will lead to the reopening of fields that have been drained by shallow drilling.

Operators expect that improved apparatus for drilling will enable them to sink wells as deep as 10,000 feet within the next few years. Already contracts are being signed in the region of Long Beach, Calif., stipulating a certain percent royalty to land owners for wells not deeper than 10,000 feet, and an increased royalty if wells deeper than that are used.

Our New A.C. Set Completed

How to Add Audio Amplification to the Two-Tube Outfit Described Last Month, and Get Loudspeaker Reproduction

By ALFRED P. LANE

THE four-tube, full electric radio receiver detailed on these pages is the two-tube outfit described last month in POPULAR SCIENCE MONTHLY, with the addition of two stages of audio amplification to get loudspeaker operation on most stations.

A B-eliminator has been added. This can be either a factory built unit or a home assembled outfit.

In connection with previous articles describing this receiver in its simpler forms, many readers have inquired concerning the relative merits of the receiver fitted with plug-in coils or with simple, home-wound coils.

When fitted with the plug-in coils as shown here, it is a combination short and long wave receiver. As a short-wave set it is used with three tubes, since the radio-frequency stage is of no use on the short waves. The plug-in coils on the broadcast bands give particularly good selectivity at some sacrifice of distance-getting ability. If your interest is mainly in the short waves, and you wish to tune the broadcast bands merely for the programs of local and semi-distant stations, then the plug-in coils are recommended.

If, on the other hand, you care nothing about the short waves and you want maximum results on the broadcast band, you will do well to build the set with plain, hand-wound coils.

If you have built the two-tube receiver described last month, the cost of completing it according to the directions here given will amount to the price of two audio-frequency transformers, one output transformer, a fixed resistance, a B-eliminator, and a loudspeaker. Of course, two more tubes will be required; one type 226 and one type 171A.

For the convenience of those who have already completed the set in either one- or two-tube form we list the parts separately.

These parts are in the one-tube set:

A1, B1, C1—short-wave coil set, including extra coils to cover the broadcast band of wave lengths.
D1—variable condenser, .00014 mfd. capacity.
D2—grid condenser, .0001 mfd. capacity with clips.
D3—fixed condenser, .0005 mfd. capacity.
E1—radio-frequency choke coil, 85 millihenries inductance.
F1—grid leak, 5 megohms.
F2—variable resistance, 0 to 5,000,000 ohms.
G1—socket for heater type 227 vacuum tube.

These parts were added to make it a two-tube set:

A2, B2, C2—mounting and broadcast band coils (or home-wound coil).
D4—variable condenser, .00014 mfd. capacity.
D5—midget variable condenser.
D6—bypass condenser, ½ mfd. capacity.
F3—six-ohm potentiometer.
F4—2,000-ohm fixed resistance.
G2—standard X-type vacuum tube socket.
H—oscillation controller.

And now you need these parts to add audio amplification:

J1, J2—high grade audio transformers.
J3—output transformer.
G3, G4—standard X-type tube sockets.
F5—One-thousand-ohm fixed resistance.

You will need all of the above parts if you are just starting to construct a receiver and in addition you will, of course, need:

Drum dial, panel 7 by 21 inches, baseboard ½ by 10 by 20 inches, wire, screws, etc., as well as an A-power transformer, a good B-eliminator, and a loudspeaker.

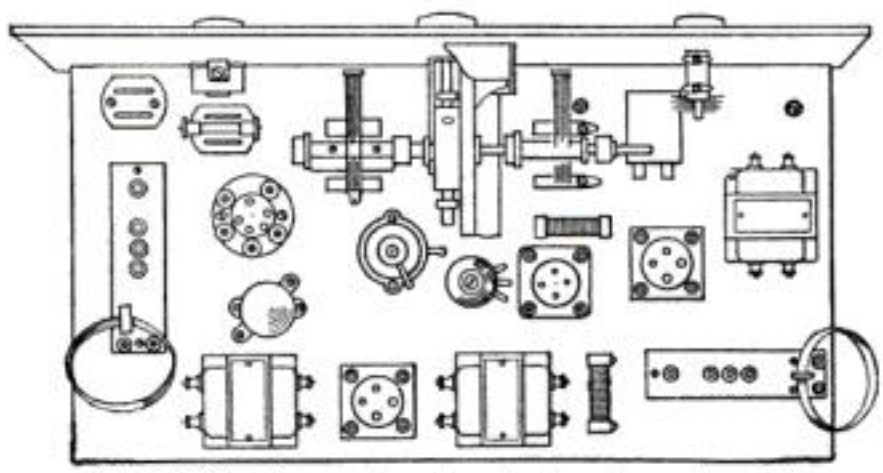


Fig. 1. This diagram shows how to place the parts on the baseboard. You can judge positions by eye measurement.

AS SHOWN here, the receiver is modern in appearance. Some readers, however, have asked whether they can use two ordinary tuning dials instead of the drum dial. This is entirely practical. Of course, if you have independent control of the two condensers, you will not require the midget vernier condenser *D5*.

This midget condenser is, however, absolutely necessary if you use the single dial control, because of the effect of the antenna on the tuning of the radio-frequency stage.

Please pay particular attention to the location of the fixed resistances *F4* and *F5*. In the two-tube circuit shown last month, the 2,000-ohm resistance *F4* was used to supply the necessary C-bias for the radio-frequency stage of amplification. In the circuit shown in Figs. 2 and 3 you will note that the new resistance you have purchased, the 1,000-ohm resistance *F5*, is located where *F4* was connected, and *F4* is moved over to act as a grid-biasing resistance for the power

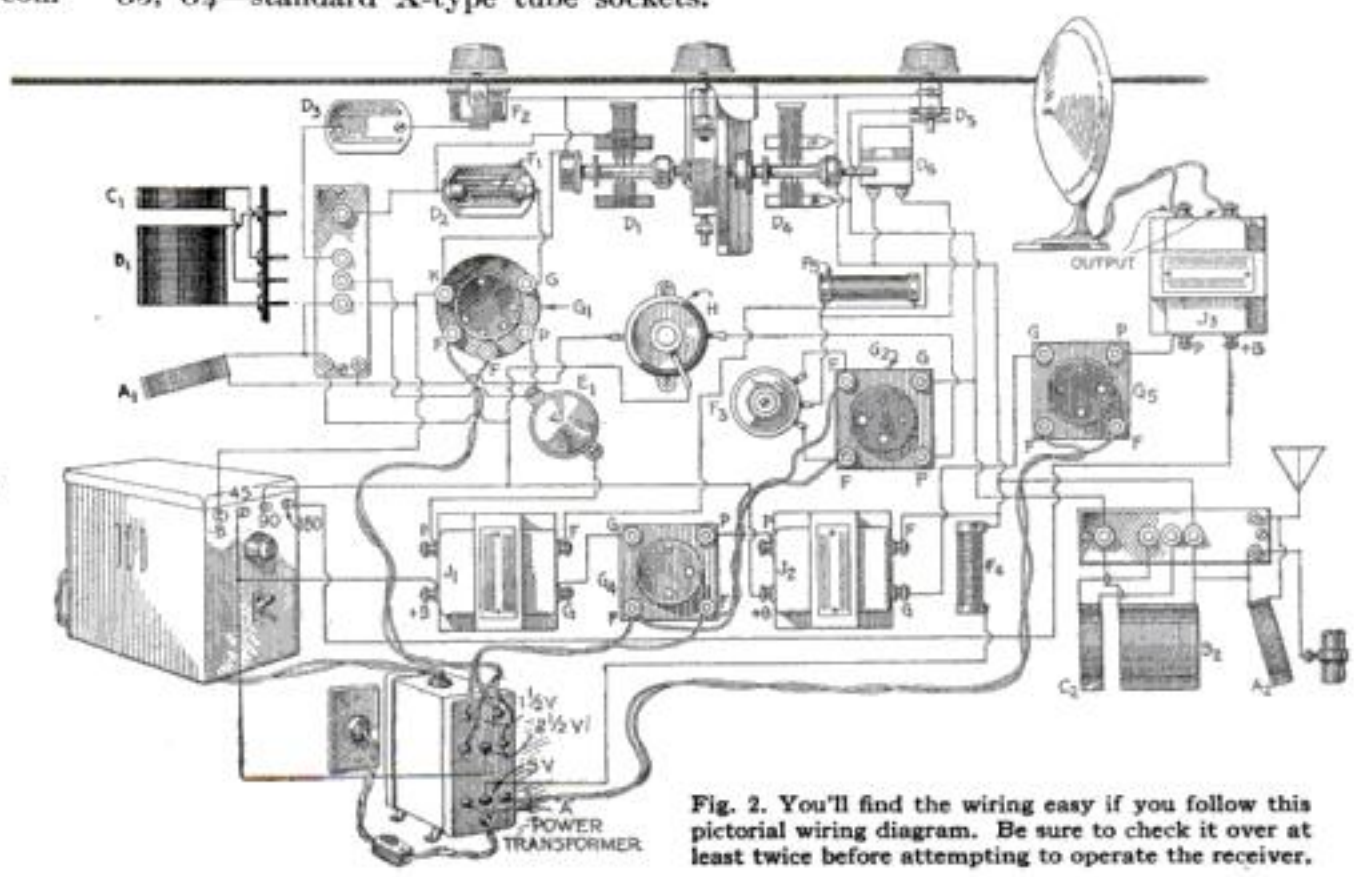
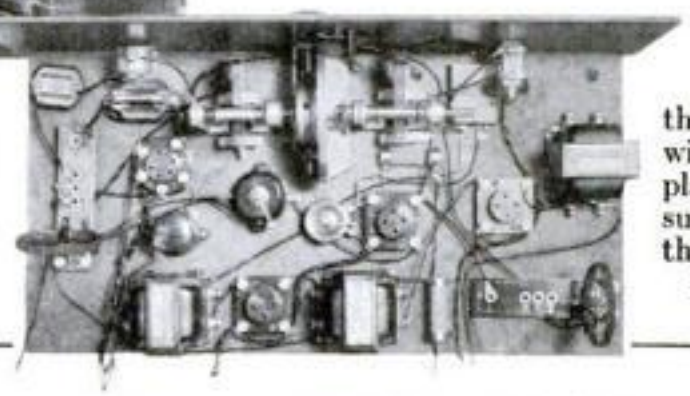


Fig. 2. You'll find the wiring easy if you follow this pictorial wiring diagram. Be sure to check it over at least twice before attempting to operate the receiver.

Testing the new full electric, four-tube receiver in the laboratory of the Popular Science Institute of Standards. It was found to be efficient and modern.



A view of the completed receiver from above, showing the layout of parts and wiring. Before beginning construction of the set, study this photograph, as well as Fig. 1.

tube type 171A in the last audio stage. The reason for this change is that in the four-tube circuit, the first audio stage is biased by the same resistance as is used in the radio stage, which means that the resistance must be dropped to half the value, since there will be twice as much current flowing through it.

Substituting *F5* for *F4* is the only change in the wiring of the two-tube circuit required when you add the parts to complete the set.

Follow Fig. 1 and the photographs on this page when you arrange the parts on the baseboard. Accuracy is not required. Merely place them by eye measurement. The drum dial should be mounted on the panel according to the instructions of the manufacturer.

Make sure that you set the various parts with the terminals pointing in the direction indicated in Fig. 2, the picture wiring diagram. This is especially important for the tube sockets and the audio transformers.

Note that no binding posts are used. Since the receiver will be permanently connected with the A-transformer, the B-eliminator, and the loudspeaker, you will find that bringing out loose wires as shown will save the expense of binding posts and the trouble of fitting them.

Even the loudspeaker cord tips can be clamped directly to the output binding posts of transformer *J3*, although if you prefer, a jack can be mounted on the panel directly in front of it.

You will find that the wiring is easy if you follow the picture wiring diagram of Fig. 2. Be sure to check it at least twice before you attempt to operate the receiver.

After checking the wiring, connect the flexible leads for the 1½-, the 2½-, and the 5-volt circuits to the proper terminals of the filament heating transformer. If you have any reason to suspect that the line voltage in your neighborhood is a bit high, you may find it worthwhile to cut down the voltages in these circuits. This applies particularly to the 1½-volt circuit, since the A-power transformers are designed to handle six type 226 tubes, and you use only two of them in this set. Consequently the voltage is likely to be somewhat high anyhow. The simplest way to cut down the voltage is to wind ten or twenty feet of ordinary bell wire on a small spool, winding half one way and half the other. Connect this in the 1½-volt circuit at any convenient point near the transformer. Reduce the length of wire if you notice any material falling off in volume.

Any high grade B-eliminator, either factory built or home assembled, will give excellent results. It should deliver a maximum of at least 220 volts if you want to get full power out of the 171A tube in socket *G4*. This tube will handle up to 180 volts applied to the plate, and the C-bias voltage of 40 is subtracted from the voltage delivered by the eliminator.

In the case of the A-power transformer, a socket is provided into which you can insert the plug from the B-eliminator. By this method all the current for operating the set is taken through the plug connected with the A-power transformer. You can turn the set on and off by inserting the A-power transformer plug in and pulling it out of the wall socket, or you can fit a drop cord switch, as shown in Fig. 2.

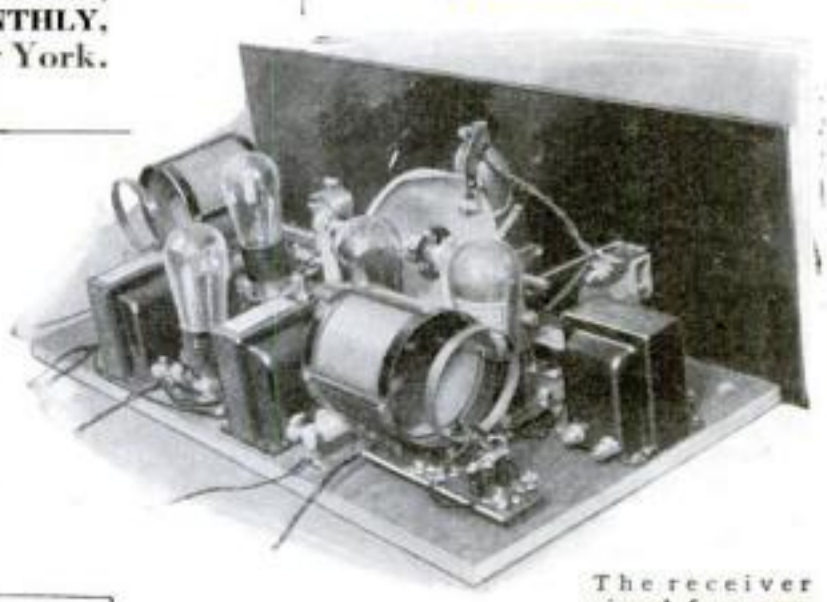
The small, six-volt light that illuminates the dial should be wired by a twisted pair of wires directly to the F terminals of socket *G4*. This light will then be turned on and off automatically.

After all the connections have been made according to Fig. 1, put the tubes in the sockets. Place a 227 tube in socket *G1*, a 226 tube in sockets *G2* and *G3*,

(Continued on page 153)

POPULAR SCIENCE MONTHLY Blueprint No. 99, describing in still greater detail the construction of this modern and easily built four-tube full electric radio receiver, may be obtained for twenty-five cents (see page 105).

A complete list of parts approved by the Popular Science Institute of Standards for use in constructing the receiver will be mailed with each blueprint or sent free to readers who wish to work from this article. Address requests for advice or information to: Technical Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York.



The receiver viewed from rear.

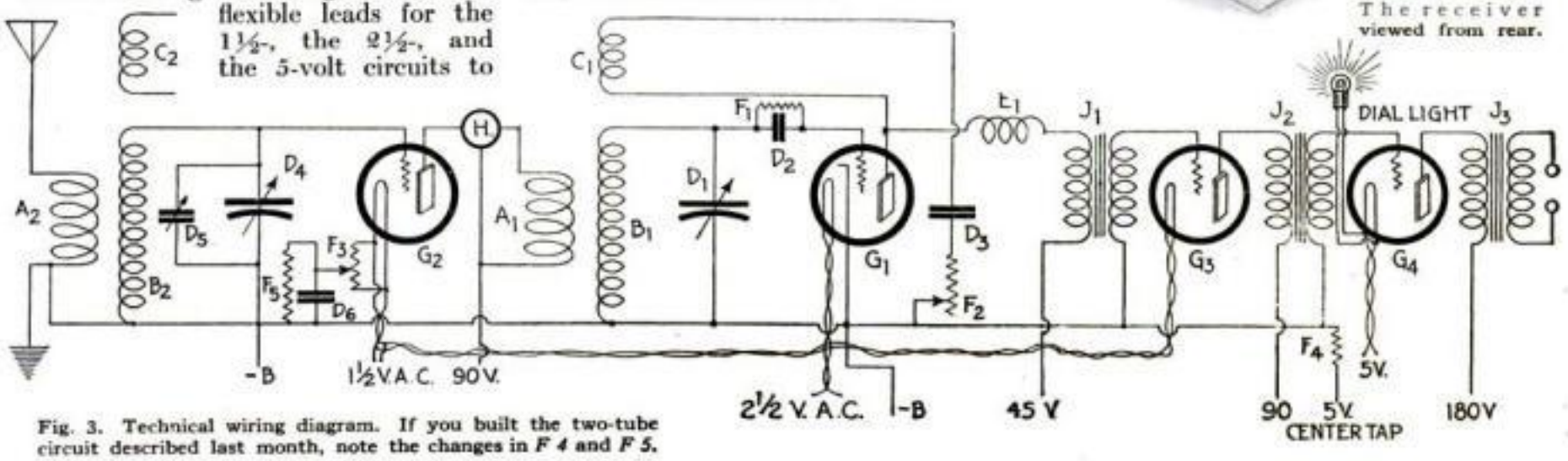


Fig. 3. Technical wiring diagram. If you built the two-tube circuit described last month, note the changes in *F 4* and *F 5*.

Useful Hints for the Radio Fan

How to Kill the "Dynamic" Hum

Noise Trouble with New A.C. Type Speakers Easily Remedied—Better Volume Control with A-Eliminator

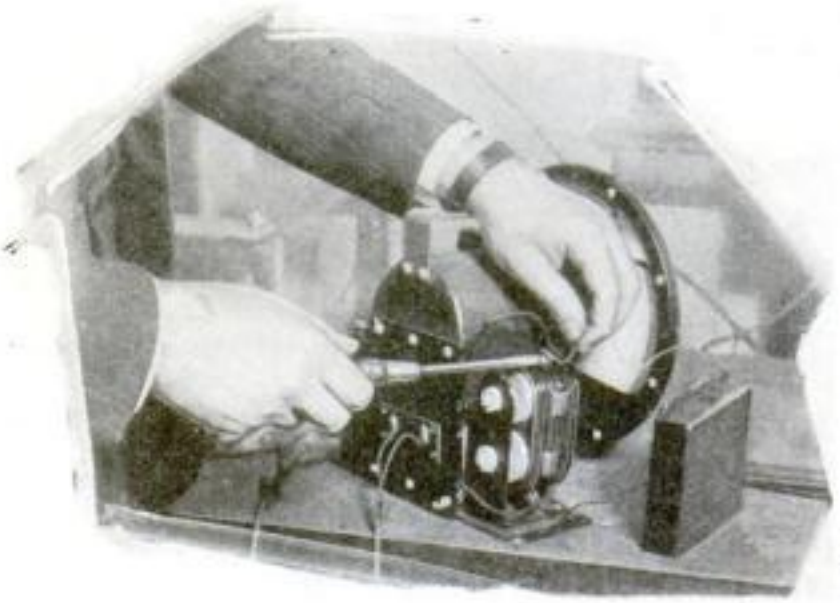


Fig. 1. Connecting a condenser across terminals of magnet coil winding kills hum in the speaker.

DYNAMIC cone speakers require a supply of direct current to energize the powerful electromagnet which seems to be an indispensable part of these instruments. Three different methods are employed to obtain the necessary current. The simplest is to make the winding suitable for use on six volts and connect it to the storage battery that supplies the filament current to the receiver.

This method of course, is ideal when a dynamic cone speaker is used with a battery set, but it won't work with the new electric sets because no battery current is available.

For electric sets, therefore, the dynamic cone speakers are made in two forms. One has a high-voltage winding through which the B-supply current of the circuit can be forced to obtain the required magnet energization. The other and more common type uses a separate step-down transformer and rectifier element. This latter type is most popular because it can be hooked to any electric set without changes in the internal wiring of the receiver.

There is, however, one trouble with the so called A. C. type dynamic speaker. The rectifier circuit is somewhat rudimentary and with certain high quality radio receivers will develop a noticeable hum.

FORTUNATELY this hum can be eliminated entirely in a simple manner. Fig. 1 shows it being done. Merely connect the terminals of a condenser, having a capacity of 2,000 or more microfarads, directly across the terminals of the magnet coil winding. Condensers of this type are available at reasonable prices. They are used in the assembly of A-eliminators and are, of course, only suitable for use on low-voltage circuits.

Locating the proper wires to which the connections must be made is simple. A check-up will show that there are wires leading from the step-down transformer to the rectifying element, and there always are two wires leading from terminals on the rectifying element into a hole in the round case that houses the electromagnet. Connect the condenser across these same terminals.

More Durable Tubes

WHEN the alternating current tubes, types 226 and 227, were placed on the market, they were rated for one and one half and two and one half volts, respectively. These voltages, of course, had been determined with scientific precision by the laboratory engineers who developed the tubes. Extended tests had proved that the tubes gave maximum results with these voltages and they had a normal service life.

But as frequently happens when practical experience steps in to check theoretical results, the first year's use of these tubes in radio receivers brought out some points that the laboratory experts hadn't given sufficient consideration.

Tubes may last for a thousand hours if fed with exactly two and a half volts, but uniform voltages don't flow from the electric light wires. The voltage fluctuates up and down and the result has been that a great many tubes gave out long before their appointed time.

Further development of the 226 and 227 tubes has resulted in a solution of this problem. The tubes now being sold have heavier elements so that they will safely stand any ordinary line voltage fluctuations.

A B C's of Radio

THE A-current supplied to a vacuum tube, either of the battery type or the newer alternating current type, is used to heat either the filament or the electron-emitting cathode.

Compared with the battery tube, the alternating current tube obtains its A-current at less expense than does the battery tube. In consequence, the alternating current tubes are designed for a relatively heavy A-current. And by still further increasing the A-current, an otherwise poorly designed tube can be made to give a creditable showing.

Many makers of inferior tubes resort to this method of getting results. The use of such inferior alternating current tubes will cause trouble.

Better Volume Control

A PECULIAR situation has developed with regard to the use of modern types of A-eliminators. You may install one of these pieces of apparatus to run the receiver formerly operated with a storage A-battery. The outfit will prove satisfactory except in one way. You may notice that while distant stations are received about as usual, powerful local stations may fade in and out mysteriously. The A-eliminator is indirectly responsible.

The usual method of volume control on all good battery sets is to fit a rheostat in one or more of the radio-frequency stages and use it to turn down the radio-frequency amplifier tubes when it is desired to decrease the volume. This adjustment is quite critical, and when you use an A-battery eliminator the slight fluctuations in the line current voltage are reflected in the output of the instrument and the amplification of the tubes is, in consequence, greatly affected.

The remedy is to install another type of volume control; as shown in Fig. 2.

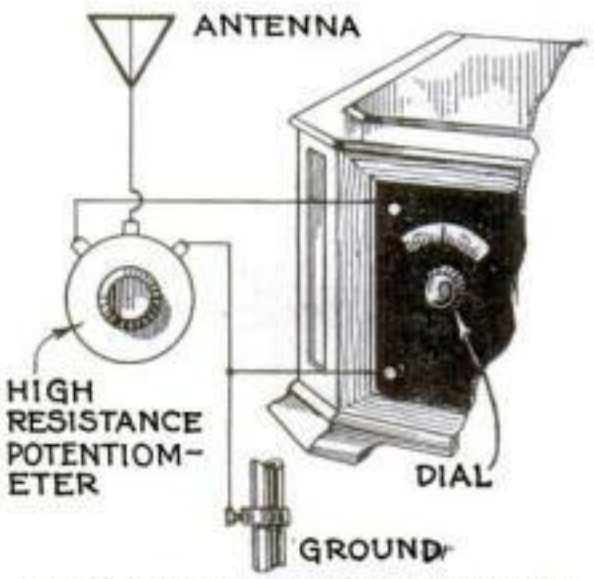
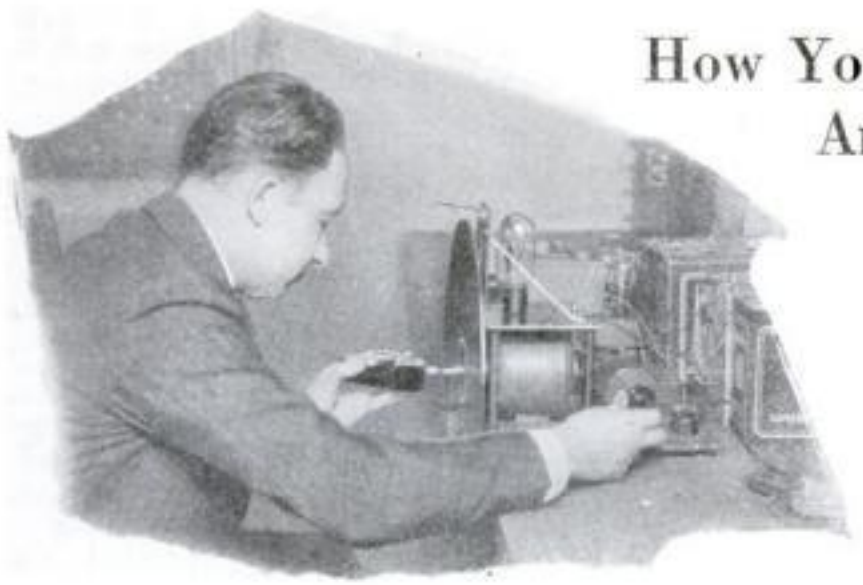


Fig. 2. A simple potentiometer volume control for radio receiving sets using A-eliminators.

Your First Television Set



How You Can Build and Operate an Amateur Experimental Apparatus Hooked to Your Radio Receiver

By

JOHN CARR

Adjusting speed of scanning disk with a tachometer, or speed indicator, in Popular Science Institute laboratory.

THE accurate construction of one of the most important parts of a television receiver, the scanning disk, was described in the December issue of POPULAR SCIENCE MONTHLY.

The three vital parts of the television receiver are the scanning disk, the neon tube, and the motor that rotates the disk. There is, of course, the radio receiver, but this is not distinctively television equipment, because it differs in no essential from any really high-class radio broadcast receiver.

The other parts of the television equipment are merely accessories designed to assist in the proper functioning of the important parts.

You must have a high-grade radio receiver to get satisfactory results in television. This means that the receiver must bring in the station with plenty of volume whether you are receiving on the broadcast or the short-wave band. Furthermore, the audio amplifier of the receiver must amplify without serious distortion all audio frequencies, from the lowest commonly used in the broadcasting of music or speech, up to at least 5,000 vibrations per second. This range will give fair results. On some of the television broadcasting, even better results will be obtained with a receiver that will amplify up to 15,000.

A variable speed motor is an absolute necessity, for you must be able to rotate your scanning disk at a speed which will be exactly in step with the scanning disk used in the television broadcasting station.

THIS matter of obtaining synchronism is the most difficult problem at present. There is no method available for amateur use that does not require constant and extremely careful hand adjustment all the time the vision is being received. The slightest error will throw the vision into a chaotic blur of dots and streaks.

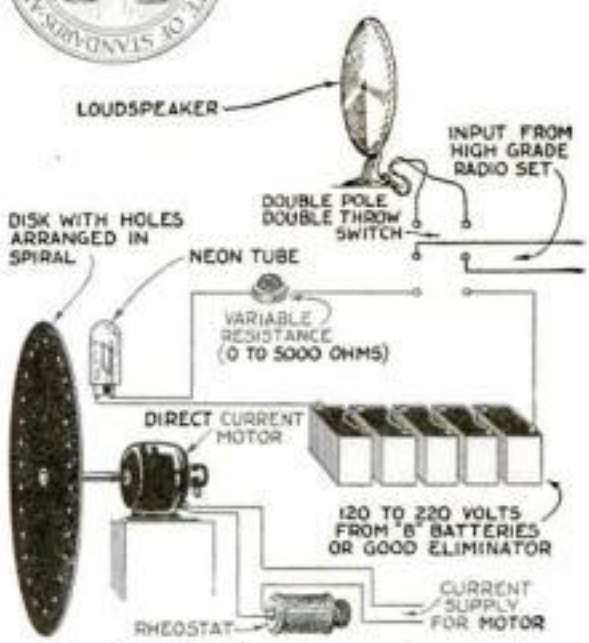
In the Popular Science Institute of Standards laboratory we have found that the simplest and most accurate way to get synchronism is to adjust the motor rheostat so that the disk will run slightly faster than is required. Then we rest a hand in a comfortably supported position close to the edge of the disk and lightly touch the side of the disk close to the rim with the ball of the thumb. The slight friction retards the disk until it strikes synchronism and it is held in step by varying the touch of the thumb.

This sounds like a rather crude system, but it works. With astonishingly little practice you will be able to hold the vision in the frame or picture space which, of course, is in front of the plate of the neon tube.

WHEN the image is being perfectly received it is stationary in the frame. As the disk starts to rotate either too fast or too slow, the image will lean in one direction or the other and will start to drift out of the frame. You increase or decrease your thumb pressure accordingly and bring it back.

The illustrations show a typical amateur experimenter's television apparatus as set up in the Popular Science Institute laboratory. At the top of the page a tachometer, or speed indicator, is shown being used to adjust the disk speed. If you haven't such an instrument you will have to experiment until you hit on the right speed.

There are no special rules for setting up the neon lamp except to get it as close as practicable to the back of the television disk, with the side of the plate that glows squarely toward the disk. To adjust the neon tube voltage, simply turn the adjustable resistance until the tube glows steadily but as faintly as possible. Directions as to the proper tube voltage are packed in the box with the tube.



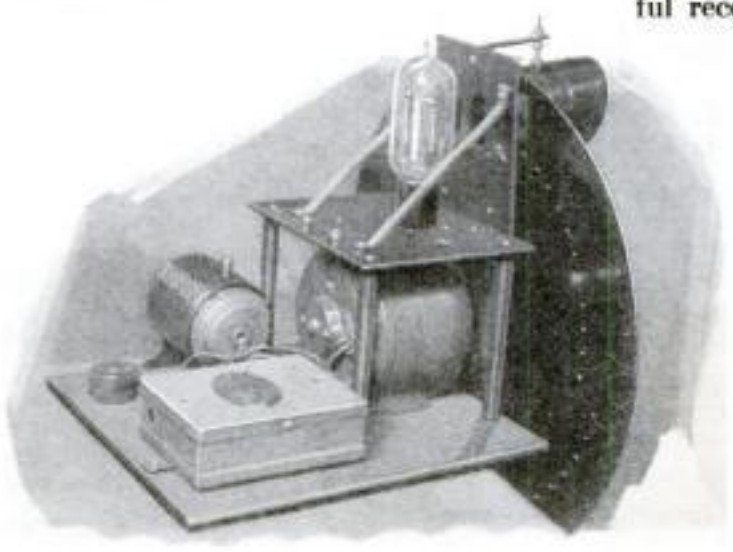
This pictorial wiring diagram shows in detail how to hook up the television apparatus.

THE diagram on this page shows the wiring. You must, of course, see that the radio receiver is fitted with an output transformer. No worth while results can be obtained unless you use at least a type 171A tube in the last stage of the set and operate it with 180 volts on the plate. Better results are obtained if a still more powerful amplifier is used.

Television receiving must be done in a darkened room. The image is not strong enough to be seen if the room is flooded with daylight. A ground glass in front of the scanning disk also cuts down the light and can be used only with a powerful receiver. The ground glass is not a necessity, however, as you see the vision just as well by looking directly at the plate of the neon tube through the holes of the scanning disk.

When you first receive a vision you are just as likely to have it upside down as right side up. If it is upside down, take the scanning disk off the motor shaft and turn it the other side to. The image will then be seen right side up. The image also may be wrong side to. This is of no particular importance on faces or ordinary objects, but it will make type read backward. To cure

(Continued on page 153)



Rear view of the typical experimenter's television apparatus as set up in the Popular Science Institute laboratory, showing usual arrangement of the parts.

Parachutes Have Snatched 115 Flyers from Death

NINETY-SIX airmen in America have saved themselves from certain death by leaping from disabled planes and trusting to their parachutes. In foreign countries, nineteen flyers have done the same, says a recent announcement of the U. S. War Department.

Colonel Charles A. Lindbergh holds the record for the number of leaps from disabled machines, having jumped four times. The first airmen to use parachutes in an emergency to save their lives are said to be John Boettner, pilot, and Henry Wacker, chief mechanic, of the American dirigible, "The Wing-Foot Express." While cruising over Chicago, in 1910, this balloon burst into flames and crashed through the skylight of the Illinois Trust and Savings Bank, resulting in the death of thirteen workers in that building.

According to the records of the U. S. Army Air Corps, there is no instance of the Army type parachute failing to open, once the jumper cleared the plane.

Gas Taxes Build Roads

MORE than two hundred million dollars were added to the price of gasoline in the form of "gas" tax last year. The tax, totaling $258,966,851 for the whole country, was levied in all of the states except two, New York and Massachusetts. The tax ranged from two to five cents a gallon. Most of the receipts went for new roads or for completing payment on highways already built.

Largest Grindstone Is Built in Sections

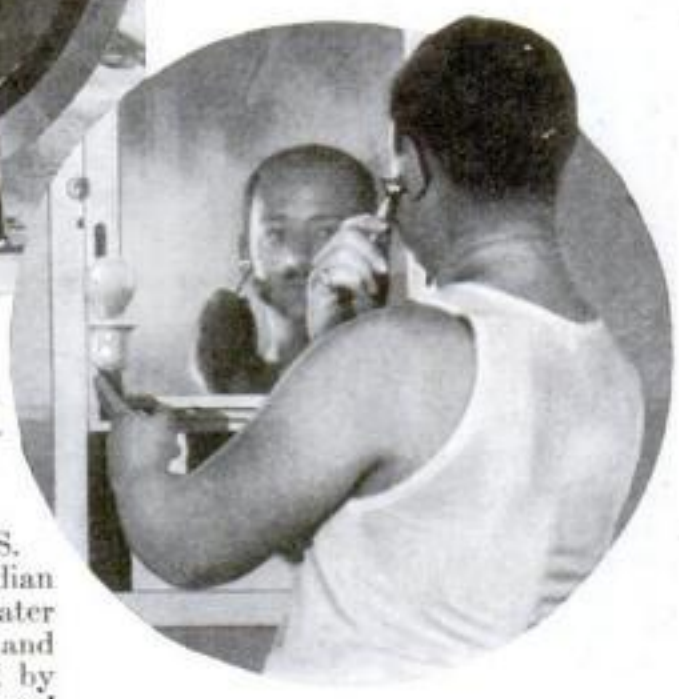
A GRINDSTONE for a giant to turn is the one recently exhibited at a machine tool and engineering exposition in England. The huge abrasive wheel, said to be the largest ever constructed, will do the grinding of tools in an English machine shop. It is six feet in diameter and fourteen inches thick. The wheel is not a solid piece of stone, but consists instead of some twenty-four small abrasive stones, each cut somewhat in the shape of the keystone of an arch, and all joined about a large central hub to form the continuous abrasive surface of the wheels. The joints where these smaller sections meet may be seen in the accompanying photograph.

An interesting fact in connection with the wheel is that the stone of which it is made was sent to England from Massachusetts by an American firm.

The huge grindstone on its mounting, taller than the workman who assembled it.

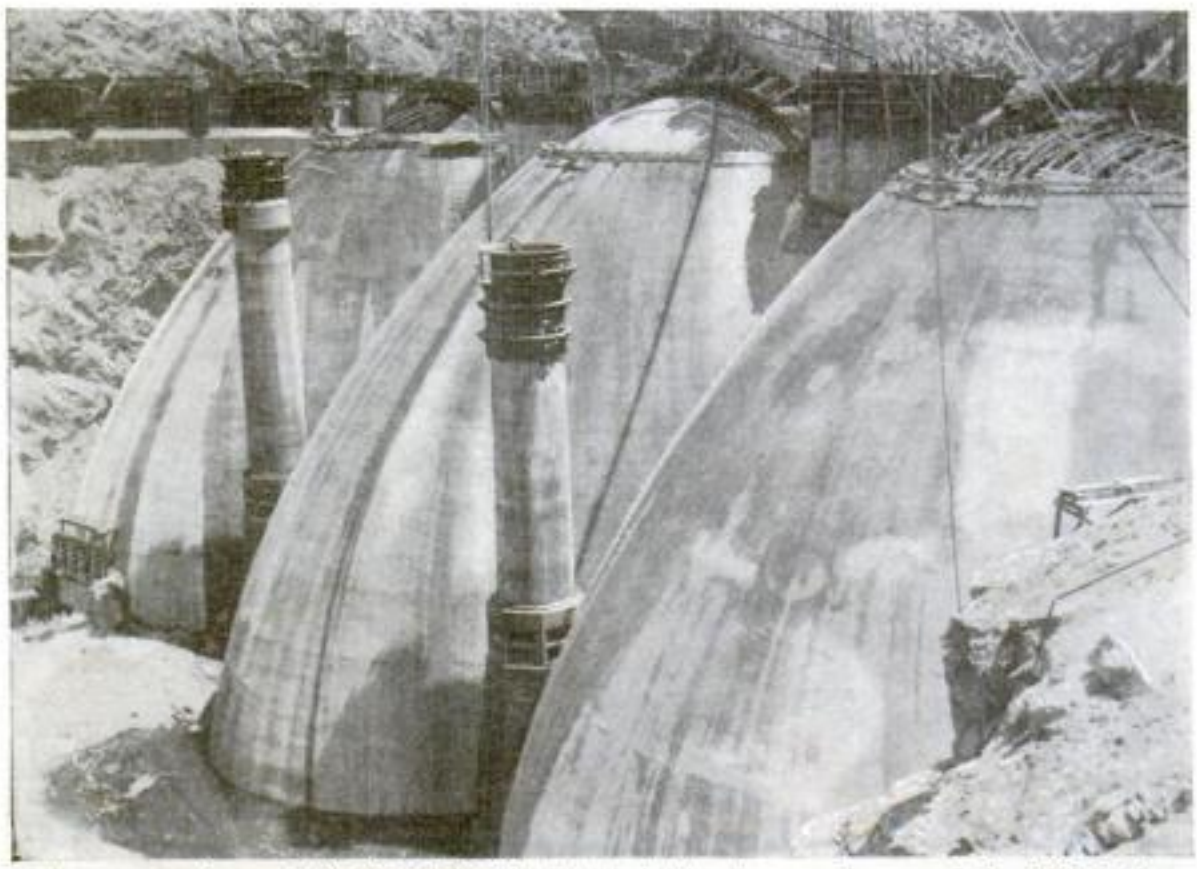
Aided by Weather Man

TELEGRAMS from the local weather bureau recently guided engineers in building a bridge across the Rio Grande at Brownsville, Texas. Information about conditions upstream during a threatened flood enabled the bridge builders to plan each day's work and to strengthen the falsework piling supporting the main structure in time to save the work which was already completed.



Huge Domes Strengthen New Coolidge Dam

RECENT completion of three huge concrete dome-shaped buttresses marked one of the final steps in the construction of the $10,000,000 Coolidge Dam on the Gila River, east of Phoenix, Arizona. These domes, said to be the largest in the world, are designed to give the dam a maximum strength with economy of material. They distribute the water pressure among a number of buttresses, and so reduce the pressure on any one. Constructed by the U. S. Reclamation Service and the Indian Department, the dam will provide water sufficient to irrigate 100,000 acres of land in Arizona, half of which is owned by the Pima Indians, whose ancestors used artificial irrigation 400 years ago.



The concrete domes of the $10,000,000 Coolidge irrigation dam, nearing completion. This is the first multiple dome dam ever constructed. Its impounded waters will irrigate 100,000 acres.

Handy Shaving Lamp Moves Around the Mirror

A LIGHT that slides in a groove about three sides of a mirror is one of the latest aids to shaving. Instead of dodging from side to side to get different portions of his face in the light, a shaver using the new mirror simply shifts the light up or down or to one side or the other as he progresses with his shaving.

The lamp socket is mounted on a movable arm sliding in the mirror slot. Friction clamps hold it in place after it has been moved. All the wiring is concealed within the mirror.

Your Choice of 765 Cars

WHEN you buy a new car, you may take your pick from 765 types of automobiles manufactured in the United States. Recent statistics reveal that many distinct models of cars are being made in this country. Instead of becoming more standardized, the styles in automobiles this year have a greater range than ever before. Prices of the various models range from $385 to $12,500.

Post Office Tries Mechanical Stamp Clerks

EXPERIMENTING with methods of eliminating the long lines of customers at the stamp windows, officials of the main post office in New York recently installed several coin-in-the-slot stamp vending machines in the lobby. The machines sell stamps at their face value, with the insertion of the correct change and the turn of a crank. Each machine, of six units, sells one-cent, two-cent, and five-cent stamps, as well as books of stamps, stamped envelopes, and post cards. Stamps in larger denominations or in large quantities still will be sold by clerks.

If postal officials consider the machines a success, they may be installed in post offices in other large cities. Not the least of their advantages, officials say, is that they will permit the purchase of stamps on Sundays or holidays when stamp windows are closed.

Demonstrating the operation of new six-unit stamp selling machine in New York Post Office.

Phone Net Widens

IF YOU own a telephone, there are 25,000,000 people with whom you can talk. A sudden increase in the number of possible connections came recently with the advent of trans-Atlantic telephone service. This number will be further increased soon by opening of Canadian transcontinental lines and by lines to South America.

New Tool Invented to Cut Curves in Wood

THE often difficult task of shaping delicate curves in wood, as in making curved legs for tables and chairs, has been simplified by the invention of this new draw plane.

Resembling a spokeshave, it has an adjustable blade which the worker can set to cut the curve he desires. With a little practice, the inventor says, any amateur woodworker can use the new tool to replace the several tools ordinarily required for such work.

Buttons, Combs, and Pens from Skim Milk

WHEN you button your shirt, comb your hair, or sign your name with a fountain pen, you give little thought to skim milk. Yet, says Dr. G. E. Holm, head chemist of the Bureau of Dairy Industry, U. S. Department of Agriculture, skim milk played an important part in producing the buttons, comb, and fountain pen.

Chemists are now using casein, one of the constituents of milk, to produce synthetic ivory and substitutes for horn, ebony, pearl, amber, and tortoise shells.

Twelve-Foot Pie Hauled to Oven by Tractors

AN APPLE pie with a 600-pound lower crust and containing 100 bushels of apples was cooked recently at Albion, N. Y. Two tractors were required to haul this one-ton culinary masterpiece along small rails into a specially-built oven. When the half-inch-thick crust was reeled on a long steel rod and carried to the huge pie tin, four men strained under its weight. It contained almost 400 pounds of flour and more than 200 pounds of shortening.

After cooking for nearly twelve hours, the champion pie, twelve feet in diameter and eight inches thick, was done to a turn. Nearly half a day was taken in cutting and distributing pieces of the pie to crowds at the fair where the unique delicacy was cooked.

Living Human Cells "Act" on Movie Screen

MOVIES will play an important part in the medical education of the future, according to scientists who attended the twenty-ninth annual meeting of the American Roentgen Society, held recently in Kansas City, Mo.

A feature of the meeting was the projection of a moving picture of living tissues, showing just what happens to the cells of the body and to cancer cells when radium is applied.

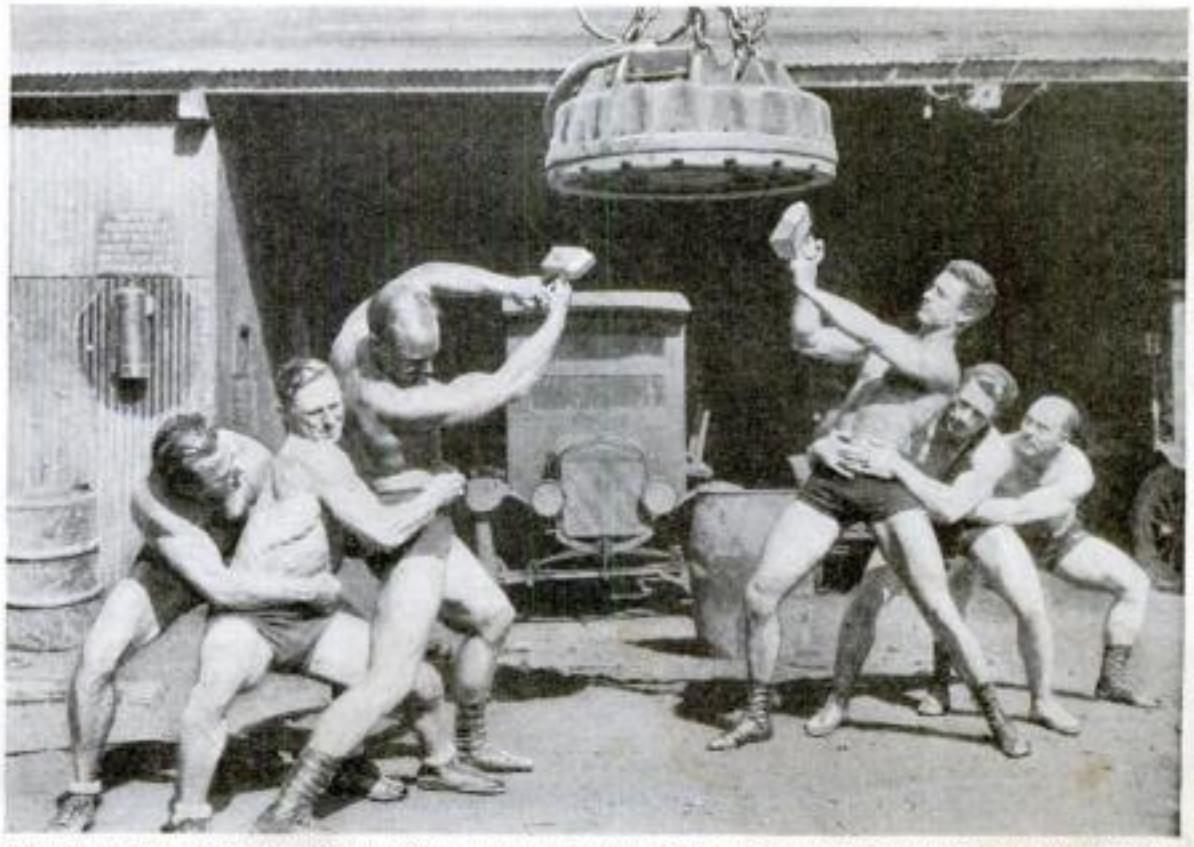
The film, made by Dr. H. G. Canti, of London, England, was shown by Dr. A. H. Pirie, of Montreal, Canada, president of the American Roentgen Society.

Strong Men Lose Tug of War with Magnet

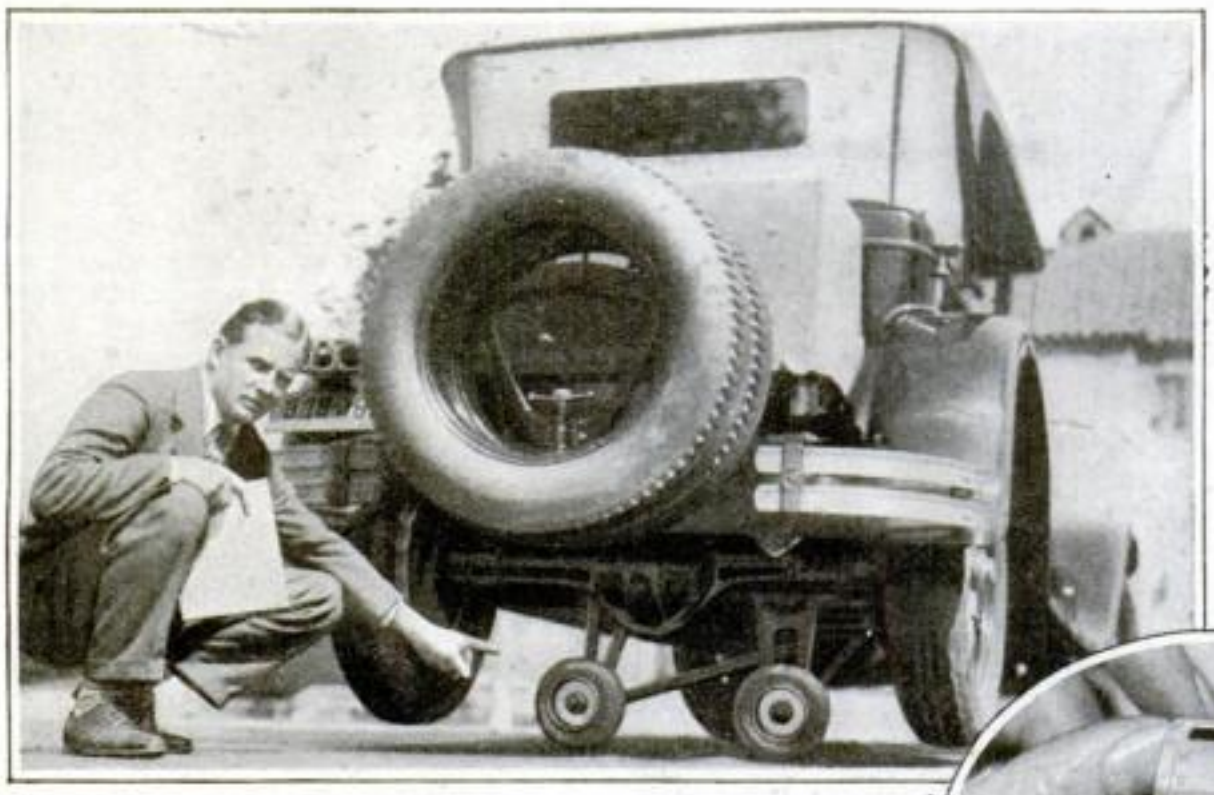
ONE of the strangest of tug of war contests was staged at an industrial plant near Los Angeles, Calif., the other day, when six professional strong men pitted their strength against the powerful magnet of an electric crane.

The men were in two teams of three men each. The leader of each team held a flatiron at arm's length toward the magnet. Then, when the electric current was turned on, he and his team mates tried to prevent the iron from being drawn to the magnet.

The magnet won against both teams. The largest magnets of this kind can lift more than sixty thousand pounds of steel.



The beginning of the tug of war. The combined power of three strong men on each team was unable to resist the terrific pull exerted by the crane's electromagnet on the flatirons held by the leaders.



Rollers Park the Car Sideways

INSTEAD of backing and twisting to get into a parking space, the driver of a car equipped with the latest parking device merely has to head into a vacant place, pull a lever, and the rear of the machine rises and swings around to the curb. It requires little more parking room than the length of the car, according to the inventors.

The lever lowers two auxiliary wheels seen under the rear axle, at the same time lifting the rear wheels of the car from the ground. Power is applied to the auxiliary wheels from the motor to move the rear of the car sideways. When the driver wishes to leave, he reverses the process, swinging out the rear of the machine. Then he lowers the rear wheels and backs into the street. The device was made by Clinton Walker and his son Bruce, of Piedmont, California.

A similar invention was brought out a year ago by a Baltimore engineer, Villor P. Williams, and described at the time in POPULAR SCIENCE MONTHLY. His device lifted both front and rear wheels from the ground and enabled the car to run sideways as far as was desired. In a test, the machine slid sideways into a parking space less than two inches longer than the car itself, without touching other parked machines.

Motor Fuel Is Made from Alcohol and Water

A NEW motor fuel, described as a chemical combination of alcohol and water, is said to have given remarkable results in Switzerland, where it was invented recently. Costing one third as much as gasoline, it is reported to give twenty percent more efficiency in motors and to assure complete combustion, leaving no residue in the cylinder.

An automobile, using the new fuel, won a recent European hill climbing contest, while a motorcycle carried off first prize in a speed race. Details of the new motor fuel are carefully guarded by the Swiss company producing it.

World's Longest Railroad

THE recent acquirement of additional lines in Kansas and Texas is said to have made the Santa Fe the world's longest railroad, slightly exceeding its nearest mileage rival, the Southern Pacific System, which has 13,165 miles of track. Other long lines in the United States include the Pennsylvania Railroad, 10,527 miles, and the Chicago, Milwaukee, and St. Paul Railway, 11,193 miles.

Oil Cup Invented to Stop Battery Corrosion

A SIMPLE yet ingenious new device designed to prevent corrosion of automobile storage battery terminals consists of a small oil reservoir made of lead, with a cuplike projection at one side, into which a felt washer fits. The terminal clamp holds both the washer and the oil receptacle firmly in place.

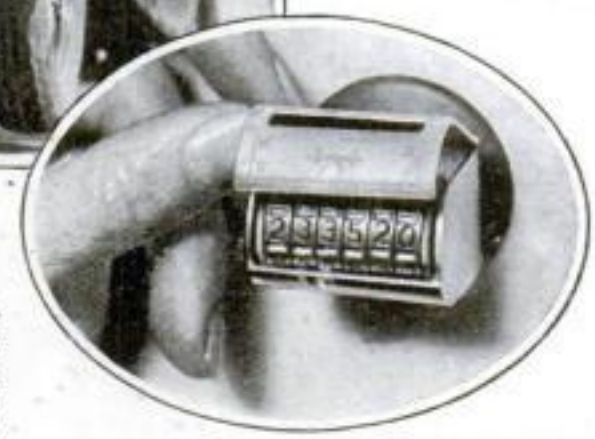
Every few weeks a little oil is squirted into the reservoir, as shown below. The felt absorbs the oil and keeps the terminal coated with a film which prevents acid from attacking it. The device has proved successful in tests covering more than a year, according to its inventor, James F. Anderson, of Akron, Ohio.

Above: Oiling battery terminal reservoir against corrosion. Right: The felt washers and filling cup.

Dashboard Register Keeps Oil Mileage Record

WHEN did you last change the oil in your crank case? Unless you are an unusual motorist, you will have to guess the answer. But with a new device, which resembles a toy speedometer and attaches to the dashboard with a rubber suction cup, the inventor says you can tell exactly when your motor needs a fresh supply of oil.

When you change oil, you set the numbers on the dial of the device at the figure registered by the speedometer. Later, as you drive, the speedometer figure mounts, while that on the device remains stationary. A comparison between the two will tell how many miles have been driven with the old oil.



Small oil mileage register attached to the car's dashboard by rubber suction cup.

New Highways for Brazil

FOR the first time a thousand-mile automobile trip is possible in Brazil, according to G. M. de Menezes, representative from that country at the recent meeting of the Highway Education Board in Washington. A new highway connecting Rio de Janeiro with Sao Paulo makes such a trip possible for motorists. It also makes a drive between the Brazilian capital and Montevideo, the capital of Uruguay, a safe trip with only a single stretch of eighty miles unimproved. For this distance the automobiles run along the smooth ocean beach.

In Brazil, additional trunk lines are planned, leading to this main highway. Two such roads, totaling 400 miles, recently have been completed.

Proposes "Smoke Rings" to Prevent Hurricanes

SHOOTING smoke rings thousands of feet into the air from twenty or thirty hundred-foot steel cones scattered over southern Florida and the Bahama Islands, is the unusual method of preventing West Indian hurricanes suggested by Prof. William S. Franklin, physicist of the Massachusetts Institute of Technology.

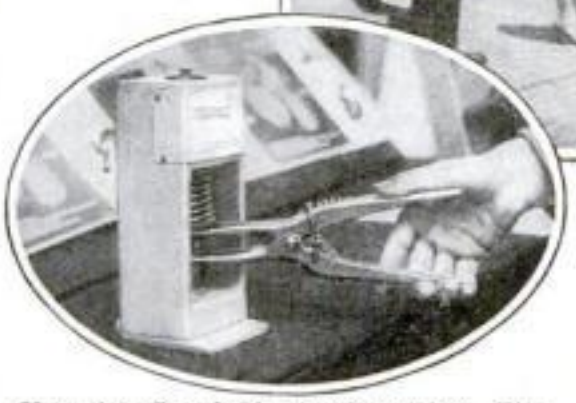
In each of the cones, a ton or more of gunpowder would be set off, the resulting explosion sending up a gigantic vortex of 60,000 cubic feet of air. This, Prof. Franklin believes, would start a rising column of warm, moist air, causing a small storm to break over each cone, and thus breaking up energy which might otherwise accumulate into one great destructive hurricane.

Prof. Franklin suggests that the U. S. Weather Bureau make a test with small cones in the tornado region of the Middle West before extensive experiments, costing several million dollars, are conducted in Florida. Scientists who are skeptical of the plan point out that past efforts to create rising currents of air by firing heavy cannon into the sky have proved unsuccessful.

Reverse Pliers Serve As Handy Valve Lifters

AN INGENIOUS tool that takes up little room in an automobile mechanic's kit, but solves the difficulty of holding up the valve spring of a motor, when cleaning around it or removing the valve, has been put on the market by a French inventor.

The device consists of a pair of reverse pliers with a series of teeth on the upper handle. The flat jaws of the pliers are inserted between the valve spring and the push rod bearing. Compressing the handles opens the jaws and lifts the spring. At the same time a wire loop slips over the teeth of the handle, holding the jaws apart. A spring connecting the lower handle and the wire loop pulls the latter toward the teeth when the handles are compressed as shown in the photo at the right.



How the pliers hold up valve spring. The jaws are held open by a wire loop and spring.

Altitude Told by Camera

HOW cameras may decide close contests for the world's airplane altitude record was demonstrated recently over Dayton, Ohio. Two Army airmen took off from McCook Field and soared to a height believed to have been 40,200 feet. At their highest point, one of the men snapped a picture of the city of Dayton far below. The weather was clear, except for a scattering of clouds at six thousand feet, and the photograph, which was taken with a special high-altitude camera, showed the various highways and main structural features of the city below clearly.

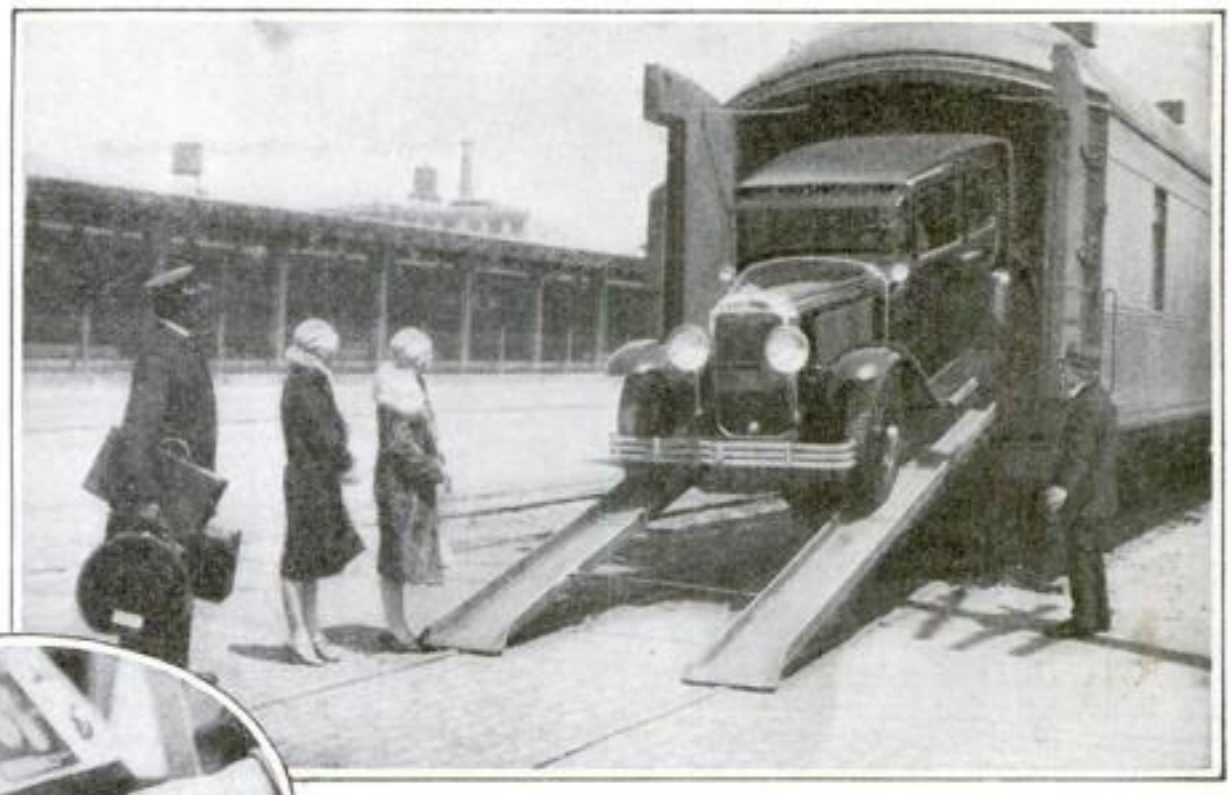
Experts say that such photographs, which show three or more distinguishable points on the ground, could be used to determine the altitude of the plane. The distances between these points are known from accurate survey data. By measuring the image separations on the negative and knowing the distance from the negative to the optical center of the camera lens, the length of the perpendicular from the lens to the ground can be determined to one tenth of one percent mathematical accuracy by solving a geometric problem.

"Thrillers" Soothe Nerves, Experiments Reveal

IF YOU are nervous, read a murder story before going to bed!

The value of this paradoxical advice seems to have been shown by a series of tests conducted recently in the University of Chicago psychological laboratories. By means of charts of pulse and respiration, and similar scientific data, it was shown that after reading a "thriller" for an hour or more, the average person tested had a quieter pulse, slower respiration, and greater self-control than before he began reading.

Ray M. Shipman, a graduate student in charge of the experiments, became interested in the calming effect of mystery stories a number of years ago when as a disabled soldier he was in a hospital for a year with nothing to do but read.



Autos Checked in Baggage Car

AN AUTOMOBILE baggage car, recently added to a fast train running between San Francisco and Del Monte, Calif., enables passengers to check their machines during the trip and to drive away in them at the journey's end. When the destination is reached the baggage car opens at one end, an inclined steel runway is put in place, and the automobile is steered to the street, where the owner and passengers enter. After the porter stows away the luggage, the machine is driven off home or to a hotel.

The new arrangement may be applied to other railroads, permitting vacationists to take their automobiles with them to distant vacation spots without having to endure the strain of the long drive.

Invents Anti-Glare "Specs" for Night Drivers

DRIVER'S spectacles designed with the upper halves of the glasses colored green are the latest idea for protecting the eyes from the glare of approaching headlights at night. When you meet dazzling headlights, simply drop your head slightly and look through the green, explains the sixty-year-old California motorist who invented the specs.

The lower halves of the glasses are slightly smoked to soften sunlight in summer driving. The goggles also are intended for golfing and beach use, the green portion serving as a sunshade.

The upper halves of the glasses are colored green to shield the eyes against headlight glare.

May Save Lives of Carbon Monoxide Victims

IF A new resuscitation method, recently tried in animal experiments in the laboratory of Dr. Ludwig Schmidt-Kehl, of the University of Würzburg, Germany, proves as successful in the case of human beings as it has in that of cats, there will be fewer victims of carbon monoxide asphyxiation in closed garages in the future. Attempts at committing suicide by inhaling illuminating gas also may be thwarted by the new method.

Dr. Schmidt-Kehl claims to have revived cats, almost dead from carbon monoxide asphyxiation, by placing them in a closed chamber of pure oxygen under pressure which was alternately decreased and increased in time with the animal's own natural breathing rate.

The scientist explains that carbon monoxide poisoning is caused by the abnormal appetite of the red blood corpuscles for the unwholesome gas. They take it up 250 times as readily as they do oxygen, and are destroyed as a result.

In this connection, Dr. Schmidt-Kehl points out that the blood fluid, which ordinarily carries very little oxygen, may be induced to load up with an emergency ration by placing the asphyxiated animal (or person if the method can be i nproved upon to include human beings) in a closed chamber of oxygen under pressure.

Huge Tree from Tiny Seed

A TINY seed only a quarter of an inch long produces the giant sequoia tree of California, whose average height is 275 feet and which may weigh 6,000 tons.

Stainless Steel Propellers Save Repairs

The new propeller of stainless steel. It measures nine feet in diameter, and costs $3,000.

Close-up of ordinary cast steel propeller, showing pit marks of corrosion. Left: Ferryboat driven by new propellers.

A KITCHEN paring knife has resulted in saving a San Francisco ferryboat company $12,800 a year! It suggested the feasibility of making boat propellers from stainless steel.

An engineer of the company noticed that a stainless steel knife in his kitchen even after years of constant use, did not become corroded by acids or by water. He recalled that at least once each six months the ferryboats had to be hauled from the water to repair the two propellers, one at each end of the craft. The hubs and blades soon became pitted through corrosion. The cost of hauling out the boats and removing and repairing and replacing the propellers was approximately $800 for each propeller.

An experimental propeller of stainless steel was put through a series of tests. At one end of one of the craft was fitted an ordinary cast-steel propeller, and at the other, the new stainless steel propeller. Operating engineers on the ferryboat, which made twenty-minute trips between San Francisco and Oakland, reported that within two months after installation they could notice the difference in time between a trip when the new wheel was propelling the boat, and one when the cast-steel propeller was used. Figures kept by these engineers showed a reduction of six percent in operating costs, greater ease and efficiency of operation, and higher speed when the new propeller was driving the boat.

When the experimental screw was examined after months of service it showed no corrosion or barnacles.

The steel that goes into the new propellers has a tensile strength of 75,000 pounds. They cost $3,000 apiece.

The Birds Set Records in Trans-Atlantic Flight

THE first trans-Atlantic flyers were the birds. A British ornithologist, T. A. Coward, has made a collection of the records of their feats of over-sea flying, which show the remarkable stamina of the feathered voyagers and their uncanny ability at navigation.

A tern, banded in Maine, was found at the mouth of the Niger River in Africa. A lapwing, banded in Ireland, was caught in Newfoundland the following year. Three kittiwakes, found living in Newfoundland, had been marked on an island off the Northumberland coast of England. These birds, of the gull species, could rest on over-water flights, it is said, as they are strong swimmers and sea-sleepers.

A relative of theirs, a black-headed gull, that had been banded in Prussia, was seen on the eastern coast of Mexico. Two American species of cuckoo sometimes reach the British Isles.

Odd "Duck" Suit Permits Walking in Water

A MAN can walk through deep water and across streams if he wears a strange suit recently tried out with success by firemen in Germany. A life preserver-like buoy about the waist keeps the wearer afloat and weighted shoes keep him in an upright position. Small paddles, operated with both hands, help propel him forward at a fair rate of speed.

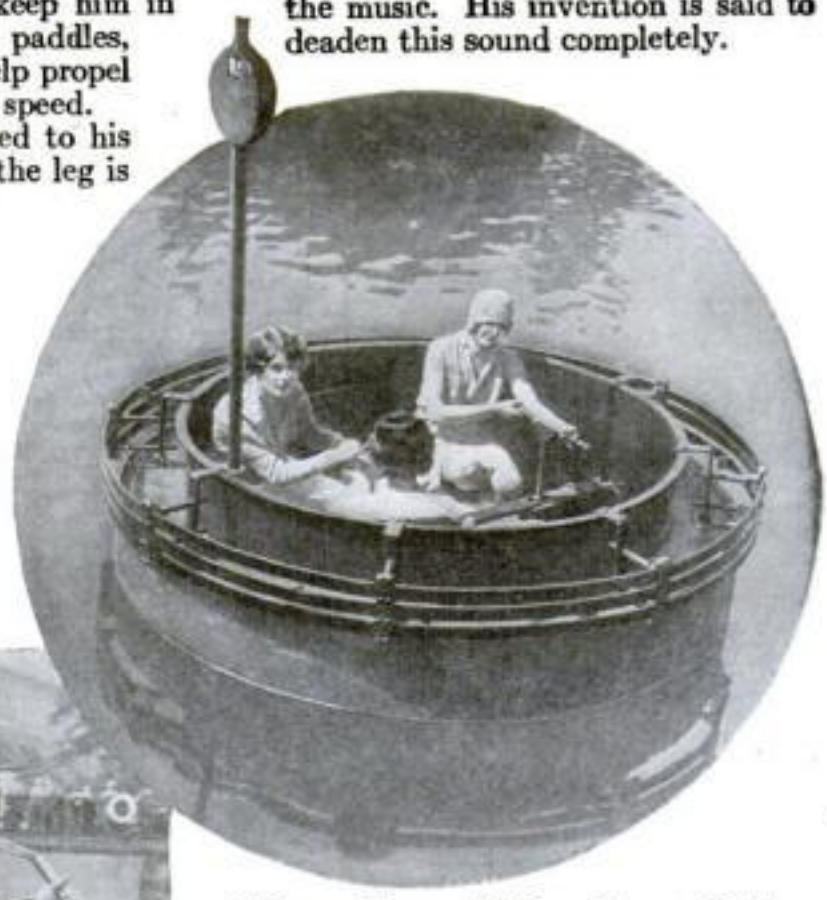
Queer metal wings attached to his feet and ankles open when the leg is pushed back and close when it is brought forward, similar to the action of a duck's webbed foot. This drives him ahead and up, adding to his progress through the water.

The suit itself is made entirely of rubber and can be slipped on over ordinary clothing, which it helps to keep dry during the time spent in the water.

Ready for a stroll through the water. The strange outfit includes hand paddles, fins for the feet, and life preserver around the waist.

Radio Piano Invented to Hush Twanging Sound

A "RADIO PIANO," designed to eliminate the twang of vibrating wires in radio reception by transmitting only the pure tone when the keys are struck before the broadcasting microphone, has been designed by an inventor in Toulouse, France. He explains that ordinarily the sound of vibrating wires in the instrument is lost to the ear when a piano is played, but that the delicate broadcasting apparatus catches and magnifies such sounds, marring the effect of the music. His invention is said to deaden this sound completely.



"Doughnut" Rowboat Offers Novel Water Sport

THE "Dippy Boat," a queer round metal craft propelled by invisible oars, was tried out recently by its inventor, Julius Goldman, in Los Angeles, Calif. A large circular pontoon, filled with air, supports as many as eight people.

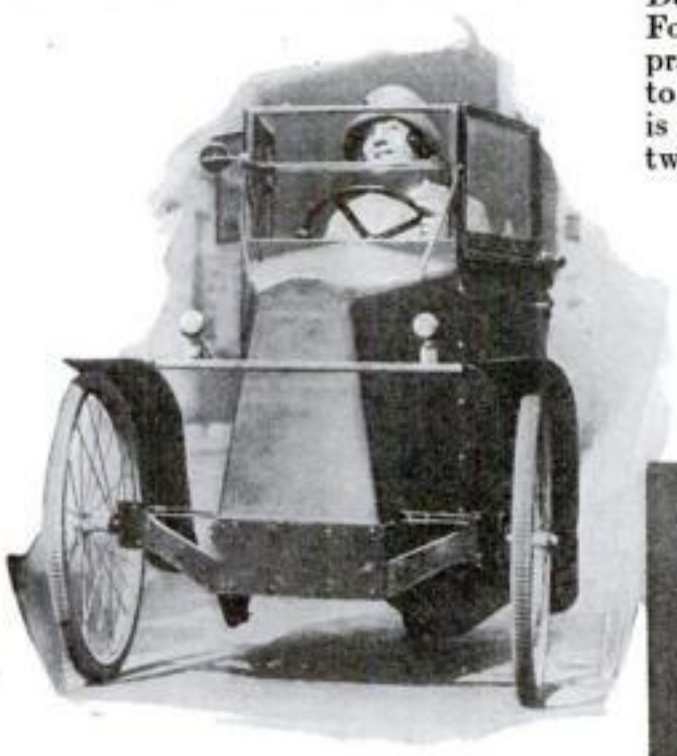
The craft is propelled forward or backward, and also steered by means of the handles being operated by the passengers in the photograph. These handles are connected with oars which move under the body of the tanklike pleasure craft. A bumper extends around the outside of the boat. This allows two or more "Dippy Boats" to collide and give the passengers a thrill without doing any harm.

Life's Riddle Is Nearly Solved, Says Chemist

DISCOVERY of the secret of life—the crowning achievement of science—seems just around the corner, Prof. F. G. Donnan, London chemist, recently told the British Association for the Advancement of Science.

Describing the work of Dr. A. V. Hill, noted British biologist, he announced that this expert is on the verge of discovering, if he has not already found, a principle "of astounding importance to science"—a series of facts that may enable science dimly to understand the difference between life and death, and hence the very meaning of life itself.

Dr. Hill's extraordinary experiments, Prof. Donnan says, have already shown that a living cell, such as a cell of the human body, must keep in a state of constant activity or it will break up and die. And this activity, which is a series of fairly well understood chemical reactions, is maintained solely by a continual supply of oxygen from the blood. In other words, the difference between a dead cell and a cell with the vital "spark" of life seems to be solely that the live one is a top-heavy, complex structure kept in equilibrium by nothing more mysterious than direct chemical action.



Speedy "Footmobile" Folds and Parks in Closet

WHEN you reach home in this runabout, you can fold it up, take it into the house with you, and park it for the night in a closet! It is a folding "footmobile" recently introduced in England, where wide use of it is predicted.

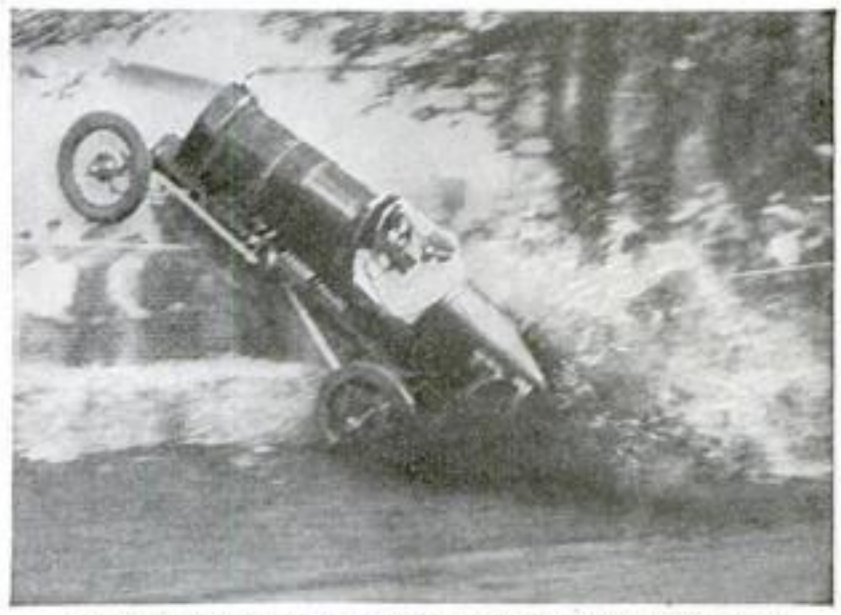
The foot-propelling mechanism has three gears, and the bicycle wheels, running with a minimum of friction, are said to carry the light car at speeds of twenty and thirty miles an hour, without great effort by the driver.

Just as in larger machines, the little vehicle is entered through a door at the side. It is equipped with a windshield and side screens, headlights, and even a rear-view mirror. Both hand and foot brakes are provided to permit sudden stops in heavy traffic. Ingenious hinges at the center permit the vehicle to be folded to half its normal width for easy storage.

Camera Clicks as Racing Car Climbs Fence

RUNNING wild at more than a mile-a-minute clip! Out of the driver's control, with its steering gear useless, this racing car plunged toward the iron fence that borders the track at Mineola, N. Y. Spectators scuttled for their lives as it slammed into the barrier and reared its nose skyward, only an intrepid photographer remaining to snap this remarkable picture.

Miraculously the driver of this car, William Darragh, escaped with minor scratches. A number of the spectators who were standing on the outside of the fence were injured and the racing machine itself was badly damaged.



Snapped just as the speeding machine plunged into the fence.

He Agrees to Kill Five Million Prairie Dogs

ONE of the strangest contracts on record was made recently in South Dakota, when A. R. Plummer, of Belle Fourche, signed up to kill 5,000,000 prairie dogs in two years. He contracted to eradicate a prairie dog "town" which is so extensive that it occupies parts of two counties. Its inhabitants are estimated to number at least 5,000,000. Their rapid increase has practically destroyed the usefulness of the land for agricultural purposes, while their burrowings have reduced its grazing value one half. Thousands of acres will be restored to usefulness if Plummer wipes out the pests.

How the ingenious foot-power machine folds up for parking in the house. The upper picture shows the car spinning along the road.

Champion Linguist Knows Two Hundred Tongues

THE world's record for proficiency in foreign languages is said to be held by a retired mathematics professor in Frankfort-on-the-Main, Germany. He knows 200 tongues. He claims to be able to read and write all of these languages, ranging from Sanskrit through Egyptian hieroglyphics and Chinese picture writings to modern tongues, and he is constantly adding to his list.

Last year, although he is an old man, he tackled four new languages. In the little house where he lives, he has 15,000 volumes, collected from all over the world and representing dialects and characters that would puzzle a trained philologist. Men from the Orient and other distant places have journeyed to this modest house to consult him.

He believes that Phoenician is the most important of all the 200 languages he knows. For relaxation after his studies he writes poetry, saying the music of rhyming words soothes the mind.

Record Overland Vision Nearly 200 Miles

HOW far can the human eye see over the surface of the earth?

Engineers on the French Mediterranean coast are reported to have sighted lights atop the mountains of Corsica, a distance of 168 miles from the coast of France.

In the United States, twelve-inch mirrors on Mount Shasta, in California, were recently seen from Mount Helena, one hundred and ninety-two miles away.

Plane Terrifies Pygmies

SO TERRIFIED were New Guinea pygmies by the apparition of an American airplane out of the sky that it took members of an aerial expedition exploring the country hours to convince them that no harm would come to them.

"They bolted for cover in all directions when we dropped from the clouds in our airplane," Dr. W. W. Brandes, of the U. S. Department of Agriculture, who headed the party, reported when it recently returned to civilization. It had covered 11,000 miles of wild country.

Keeps Hundreds of Antique Clocks Ticking on Time

ANTIQUE clocks may be ancient, but those in the collection at New York University, New York City, must not run behind the time. So Professor D. W. Hering, in charge of the James Arthur collection, has a job on his hands. He is here pictured making the rounds of the hundreds of ancient time-recorders to regulate them.

The clocks are so numerous that when a change is made from standard time to daylight saving time, Prof. Hering must begin setting the clocks two days before the date set for the change. The collection has been in the process of accumulation for nearly half a century. It is the largest of its kind in America and, including watches, contains about two thousand ancient timepieces.

Some of the old grandfather clocks date back to the early sixteen-hundreds, and were among the first of the kind constructed.

Upside-Down Skyscrapers Proposed in Japan

AN "UPSIDE-DOWN skyscraper," descending eighty stories into the earth, is suggested in Tokyo, Japan. The building would be sunk 1,100 feet deep. The design calls for a huge circular well braced with steel framework. The offices would be lighted continually with electric lights, and ventilating shafts would provide the necessary fresh air. Telephones would connect the offices with the buildings of the city above and high speed elevators would carry the workers down to their places of business.

Since the disastrous earthquake in 1923, attention in Tokyo has been turned to seeking earthquake-proof designs of architecture. The project of a downstairs skyscraper was made with this end in view. The cost of such a building is estimated at $11,000,000.

A somewhat similar suggestion for solving traffic congestion by building deeper into the earth has been made in Paris. A network of deep tunnels to carry freight, cars, and pedestrians is proposed.

Lighted House Numbers, Law in Stockholm

HOUSE numbers that can be seen in the dark are required on all homes in Stockholm, Sweden, by a recent municipal ruling. In the winter, darkness falls early, sometimes by two o'clock in the afternoon, and the difficulty of finding addresses in unfamiliar districts aroused the city officials to action.

All house numbers must be placed a certain height above the street and must be illuminated. The approved type of lighting consists of an electric lamp under the number on an arm that extends out over the street.

Plane's Wreckage Tells of Amundsen's Fate

A BATTERED wing-tip float, pulled from the icy waters of the Arctic Ocean by some Norwegian fishermen recently, gave the first concrete evidence of the fate which befell Roald Amundsen and his four French companions who took off in search of the *Italia* survivors last June.

The large Latham seaplane which flew from France to Norway, where it picked up the veteran Amundsen and proceeded to Spitzbergen, disappeared on its flight in search of General Nobile and his companions of the North Pole airship.

The float was shipped back to Paris, where it was identified as one belonging to the Latham machine.

Wrecked wing float of the lost Amundsen plane, pulled from the Arctic Ocean in the nets of Norwegian fishermen.

Electricity Fights Pests; Electrocutes Rats

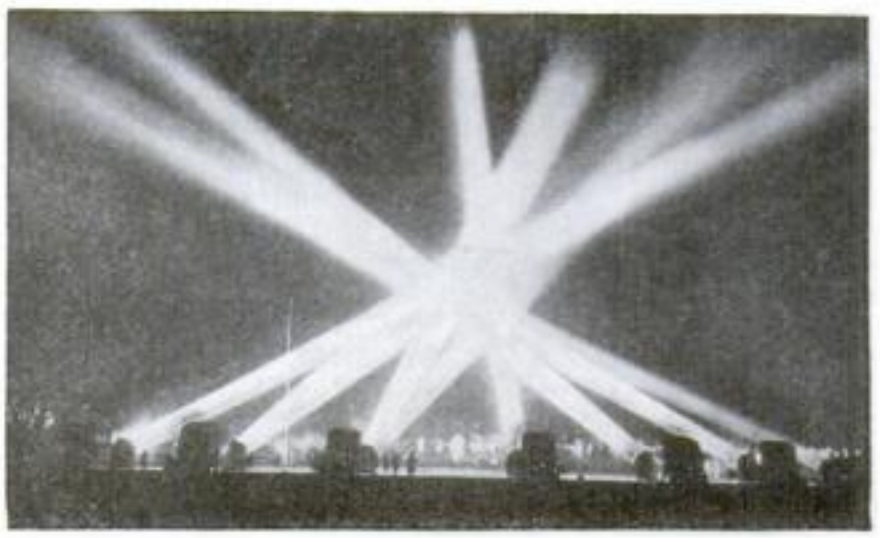
ELECTRICITY is fighting man's battle against insects and rodents in an increasing number of ways. In Switzerland, it has been used to save a field of tomatoes from grubs which formerly ruined fifty percent of the crop. Brilliant electric lights, with reflectors directed toward the soil, were placed at intervals in the field. They attracted the moths which lay eggs from which the grubs appear. Basins placed below the lamps and filled with water and gasoline caught and drowned thousands of them. As a result, fields in which the experiment was tried had an almost perfect crop, while those near by lost from thirty to sixty percent of the tomatoes. The same method has been tried with equal success in melon fields.

A new device for getting rid of rats, proposed by a Rhode Island inventor, electrocutes the rodents. A metallic disk in the center of the apparatus holds a piece of cheese. This disk is surrounded by a "live wire" in the form of a metal ring charged with electricity. To get the cheese, the rat must place his hind feet on the ring and his forepaws on the metal disk, thus completing the circuit. The inventor advises that the apparatus be placed over a barrel of water. Thus, in case the rat is stunned but not killed by the electricity, it will fall into the water and drown; also, the rat's body need not be removed to make way for the next victim.

Searchlight Battery a War Game Spectacle

LONG white fingers of light crossed and recrossed in the darkness at the recent Army Ordnance demonstration of new war material, held at Washington, D. C., as they combed the sky for night-flying aircraft as part of imaginary battle operations.

A battery of the latest huge searchlights, developed by the Army for detecting enemy flyers at night, formed one of the main attractions of the show. It drew huge crowds to watch the powerful streams of light moving in weird formations across the sky. The demonstration was held in the barrack grounds of the War College near the Potomac River. Such an exhibition of the latest developments in the war equipment of the Ordnance Department is planned by Army authorities as an annual event in the future.



A battery of huge Army searchlights, sweeping the sky for airplanes, produced this magnificent display in demonstration of war equipment.

The tight bud of the rose, hiding inner secrets even from the penetrating rays.

The bud in the slow process of unfolding; the X-rays are piercing its delicate petals.

The full-blown rose. Notice details of the heart of the bloom, seen through petals.

X-Ray Movies Reveal Blooming of a Rose

THE secret of what takes place in the heart of a rose, as it unfolds from the bud, is revealed for the first time in an amazing moving picture film recently made by a Berkeley, Calif., photographer of botanical subjects, Arthur C. Pillsbury. He employed an X-ray tube of low voltage, which casts the shadow of delicate objects upon the film, without destroying them. This tube was designed especially for the work by Dr. William D. Coolidge, inventor of the "Coolidge tube."

The camera itself is a lead-lined box with a ruby-glass opening, against which the subject is placed. In taking a succession of X-ray photographs to produce the motion picture, the film, which is unperforated, is gripped between rollers and the mechanism moves it forward as many inches as are required for each individual photograph.

The first picture made with the new apparatus was recorded on 200 feet of special film of unusual width. A small electric motor operates the camera automatically. Governed by clockwork, it turns the X-ray on and off, moves the film, and operates a brake which stops all movement at the proper time. Once started, the camera will run without attention for several days.

In making the film of the development of the unseen parts of the rose, the X-ray was turned on at five-minute intervals over a stretch of seventy-two hours. As it penetrated the petals, leaves, and stem, the film recorded the changes that had taken place during each five-minute interval.

Tests are to be made of the ability of the apparatus to record other delicate, unseen operations, such as the knitting of bones fractured in the legs of rats, the development of an embryo in a pigeon's egg, and similar subjects. Eventually it may be employed to make motion picture records, for the first time, of the operating mechanism of the human body.

Arthur C. Pillsbury, the photographer who produced the remarkable X-ray motion picture, examining the film. Note its great width. The motor which runs the camera is seen at left.

Rum Runner, Set Ablaze, Tests Fire Boat

A NEW use for rum-running vessels—that of testing the efficiency of fire boats—was demonstrated recently in the East River at New York City. One of these captured outlaws, the *Halcyon*, was set on fire in the river. As the blazing vessel drifted past one of the spans that bridge the water between Manhattan and Brooklyn, the crack fire boat of the New York Fire Department, the *John Purroy Mitchel*, its propellers churning the water as it slowly moved into position, went into action. Powerful streams of water shot from several angles upon the flaming rum runner. Hundreds of people lining the rail of the bridge were interested spectators.

In a few minutes, the torrent of water had snuffed out the blaze, demonstrating the speed with which this modern type of "water fire-engine," which patrols the waters of New York Harbor, can extinguish marine blazes.

In the shadow of one of the East River bridges, New York's crack fire boat, the *John Purroy Mitchel*, plays its powerful streams on the captured rum runner *Halcyon*, purposely set afire for the test.

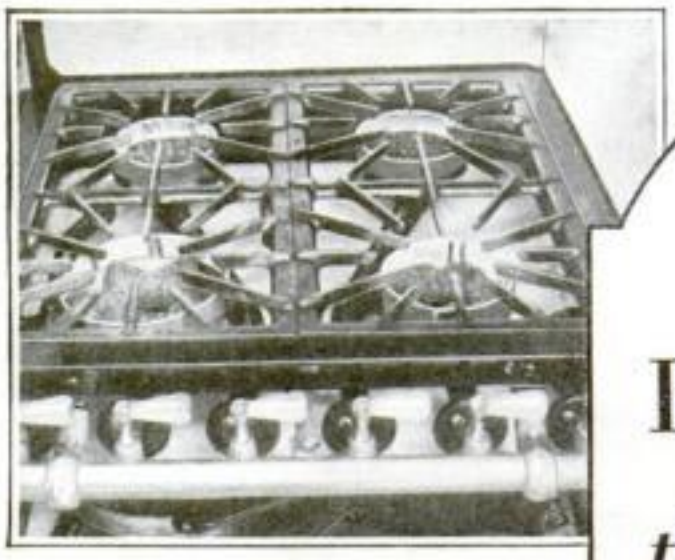
Airplane Pioneer Builds Novel Motorcycle

COMBINING the comforts of an automobile with the economy of a motorcycle, a novel two-wheeled machine has appeared in England. It was designed by A. V. Roe, famous airplane builder and the first man to make a flight in a British plane on British soil, early in 1908.

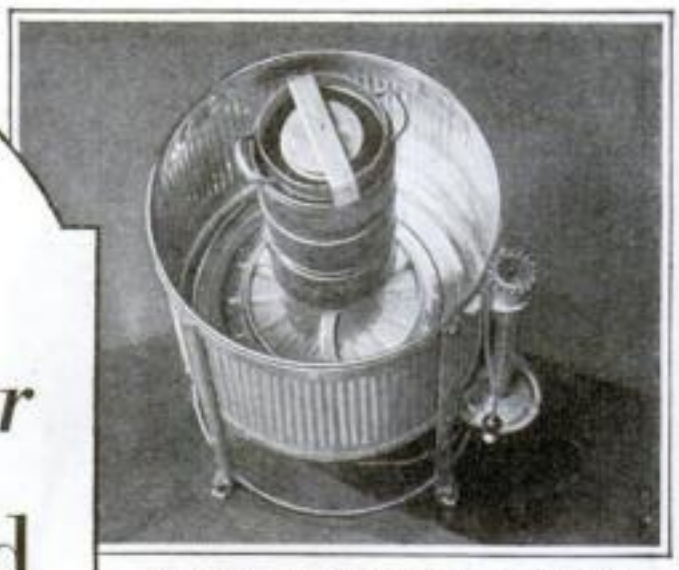
The Roe car, the only one of its kind in the world, is equipped with a three-horsepower motorcycle motor which drives the rear wheel by means of a shaft. It is said to attain a speed of sixty miles an hour, and, because of its narrow width, can squeeze through close places in traffic. The driver rests on a well-upholstered seat, protected from the wind and dust by a shield. Behind the driver's seat, the flat body provides ample room for luggage.

The photograph shows the air pioneer driving his latest invention, which is held erect when at rest by a metal stand.

Latest Inventions *for the* Household

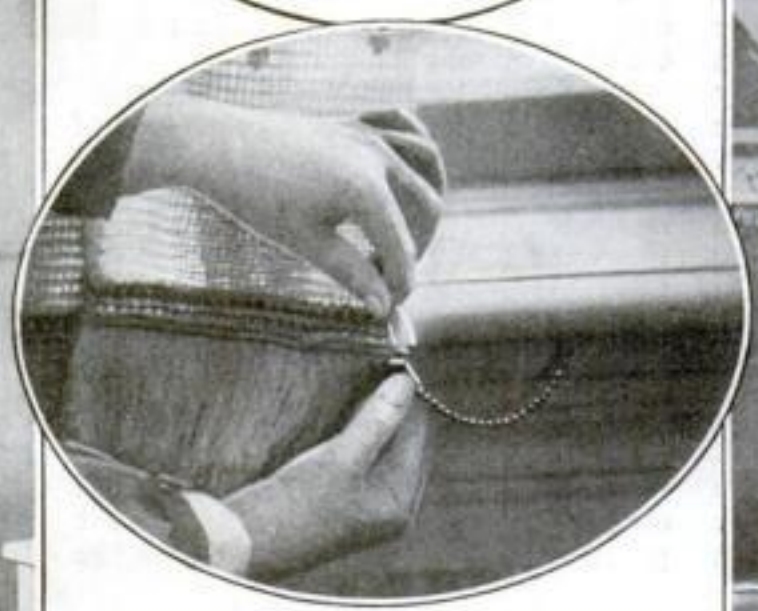


These metal rings for gas stove burners are said to save fuel by directing the heat upward where it will do the most good. In addition they aid combustion and assure a hot flame. Similar rings can be fitted to stoves burning gasoline or oil.



Now you can make ice cream with your washing machine! A new attachment replaces the dasher in any standard washing device. All you have to do is clamp it to the post, put in ingredients and ice, and turn the switch. Frozen dessert emerges.

A convenient hook on the plug of a new cord set that fits any iron or stove removes temptation to jerk it out by the wire, and saves fingers and connections. An off-and-on switch is included, if so desired.



Keeping curtains tethered, safe from soiling by rain or dust, is the job of these new clasps. Short lengths of chain grasp tabs on the curtains. Extra anchors allow a wider opening.

One handle suffices for a whole assortment of saucepans now. Many such pans, handleless, may be crowded upon a stove without inconvenience; and the new invention lifts any one of them at will.

Because many machine-packed cans have caps too tight to take off by hand, a cap-removing wrench is the latest household aid. The one above includes a bottle-opener and milk bottle cap remover.

By a clever arrangement of levers, new "nutcracker" tongs, above, grasp any size or shape of metal pan securely for lifting. Nonskid jaws that close over the rim are said to stop slipping.

Two stoves in one is the novel electric range at the left. The two-burner top, when lifted off, serves you for porch or breakfast nook meals. The lower half houses oven for kitchen use.

Something new in a cot for the baby is the two-piece crib, at right, made entirely of wood. Light in weight and easily portable, it is set up in three minutes without use of screws, hooks, or springs. It folds for storage or travel.

Both tea and coffee come from the spouts of a versatile electric percolator-brewer, solving a perplexing problem for the hostess who has guests with different beverage tastes to please.

These new panes fold inward and make it possible to clean windows from indoors. Applied to any standard double-hung wooden sash, they do not interfere with outside screens.

Within the rubber-ball tip of a novel dish-washing mop, above, is a soap chamber from which suds flow when it is pressed against a dish. No dishpan is needed; a turn under the hot faucet, a clear water rinse, and the dish is done.

Designed especially for a one-room apartment, this four-fold screen provides a miniature kitchen with shelves for food and dishes.

A new type of safety latch locks gas cocks automatically when you turn them off. Screwed on the gas pipe, it is a positive safeguard against accidental opening of a valve. A cock may be used only when the catch is depressed.

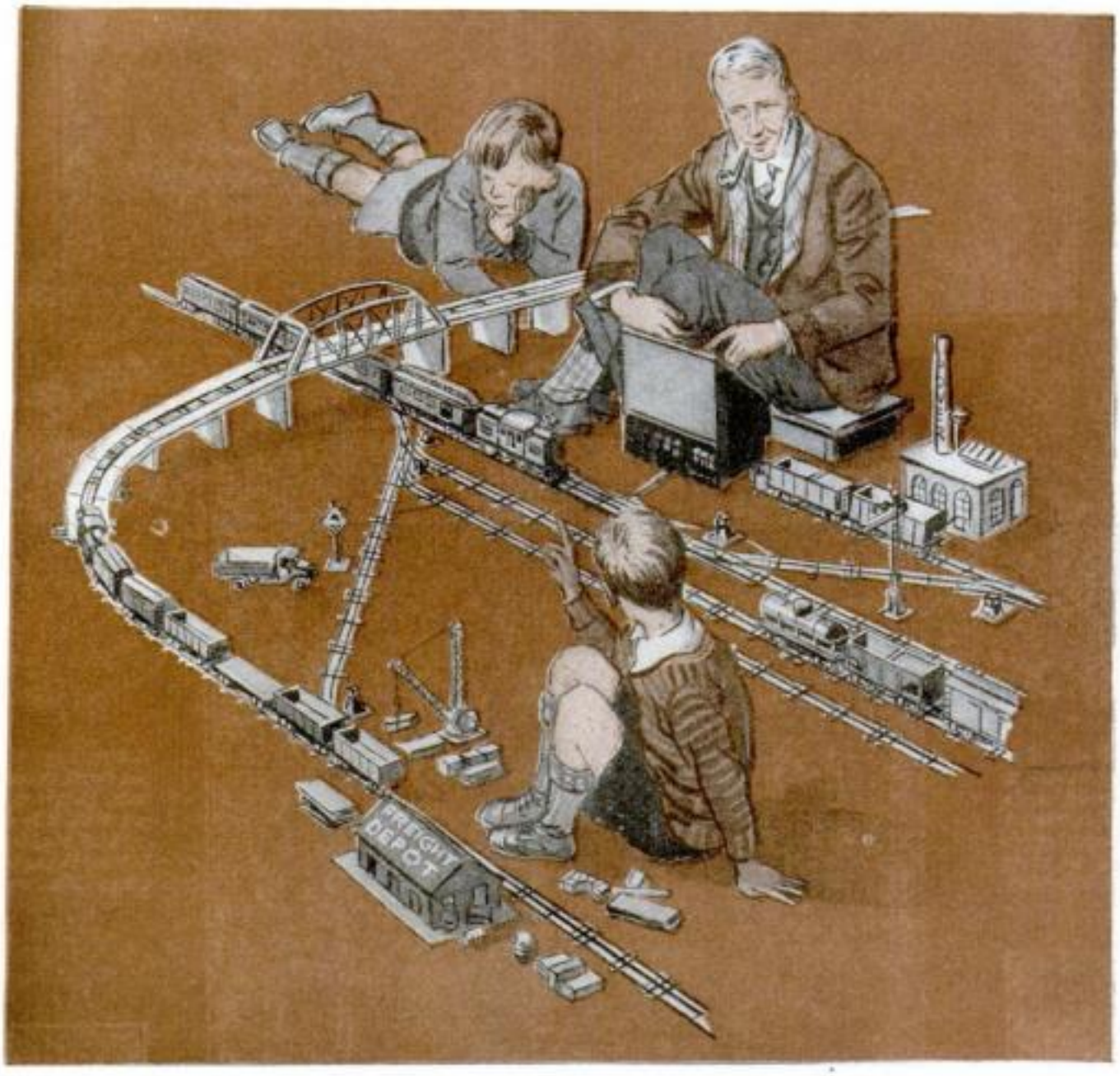
Funnel and strainer in one is a handy new kitchen tool, above. For straining, a fine-mesh sieve springs into place in the mouth of the funnel. Its handle overlaps the usual one, and a finger's touch flips the sieve out of the way to leave an ordinary funnel.

If a ginger ale or charged water bottle is recorked soon after opening it, with the new type rubber-lined cap, shown above, the unused beverage in the bottle will retain its "fizz."

Insert this new automatic siphon in a bottle, and liquid commences to flow. Remove it, and the flow stops. It fills bottles with fruit juice, or vinegar, and batteries with distilled water. Drawing out a plunger in the bottom prepares the siphon for use.

You can't cut your hand with the bread knife on this new slicer, it is said. A whole loaf at once is strapped by a band of spring metal to a wooden guard. When it is sliced, the guard is gripped by a handle beneath that keeps hand out of harm's way.

Setting Up a Model Railway



YOU can get infinitely more fun from operating a model railroad if you arrange an interesting and realistic layout of tracks.

How to Plan Your Layout to Make the Most of the Space—Laying Track—Curves and Grades—Portable Outfits—Muffling Noise

By FREDERICK D. RYDER, JR.

IN THE operation of a model railway, there comes a time when you tire of watching the train go round and round a plain circular or oval track. And then, quite logically, you decide to expand it into a more comprehensive system. As a result you buy yourself some more track, a few switches, and such other accessories as happen to appeal to you. This process is repeated several times. Eventually, your model railway loses all semblance to a real railroad and becomes, instead, a conglomeration of weird curves and impossible sidings that looks for all the world like a centipede in convulsions.

Careful planning will save you money and result in a much more interesting and satisfactory model railway.

The first step in your planning should be to decide what, in your own mind, would constitute an ideal model railway based on what you know of real railroad practice. Then you take a pencil and paper and figure out how near you can come to that ideal.

Of course, a perfect model railway would be one that duplicated in miniature every piece of rolling stock, every foot of track, and all other apparatus found on a real railroad. Obviously that degree of perfection is an impossibility. The best you or anyone else can do is to decide on some definite degree of accuracy in your model railway and strive to be as consistent as possible in maintaining it.

The foundation of any railway, whether full size or miniature, is the track layout. Real railroads have stretches of track hundreds of miles long. And right here you strike your first compromise with accuracy. The space available precludes duplicating such a layout in miniature. You will have to use your imagination and consider that long stretches of track have been compressed lengthwise to a far greater extent than would be permissible in a true scale reduction.

Since your track will of necessity be foreshortened, it seems logical to have the locomotives and cars somewhat shorter than scale length, provided, of course, that they are otherwise of the proper dimensions.

The same reasoning applies to the curves in the track. You cannot duplicate the long, easy curves of full size railroad right-of-way. Your curves must be much sharper in order to be practical in the space you have available.

The question of space governs the possible track layout. The larger the space the more elaborate the layout can be, but careful planning usually will result in a satisfactory and workable track layout even in a small space.

There are two general types of track arrangements in common use in model railway construction. One is called the "point-to-point system" and the other is the "continuous run."

In the point-to-point system the track layout includes two terminals with one or more tracks connecting them. Trains are run from one terminal to the other just as in real railroad practice. This arrangement is most popular when clockwork locomotives are used or when the space is

particularly suited; for instance, when the track must be laid in two small rooms with a long hallway connecting them.

The continuous-run track layout is far more popular. With a proper terminal (Fig. 3) it more nearly duplicates actual railroad practice because the train can be run around a sufficient number of times to simulate a long trip. You may, indeed, have one or two small way stations on the track and consider that the distance between them consists of ten or fifteen laps of the track instead of the few feet that actually separates them. Of course, it requires a bit of imagination to make this seem real, but if you didn't have a good imagination you wouldn't be interested in model railways anyway!

One limitation on the size of your model railway over which you usually have no control is the floor space that you may use for the purpose. Just so much space is available, and your problem is to work out the most practical track layout within the dimensions of the floor.

You don't, of course, have to lay the track on the floor unless you want to. It often is desirable to erect a shelf or bench around the walls and lay the track on it. This plan has much to recommend it. Working on the railway and operating it on a waist-high shelf is considerably less hard on the back muscles. Also, the track is not so likely to be damaged, and the space under the shelf can be used for storage. When the dimensions of the room are small, you may even erect a wide shelf at waist height and then a narrower shelf just above it with a grade connecting the two levels.

IT IS difficult to give any definite directions as to the actual track layout. Typical point-to-point and continuous-run layouts are illustrated in Figs. 5 and 6, but a book could be filled with the possible track arrangements that could be worked out even in a small room. However, there are certain general principles that should be kept in mind. First, remember that nothing is to be gained by making the track layout needlessly complicated. Second, observe the common railroad practice of keeping switches off the main line as far as possible. Don't force the train to run over a long succession of switches each time it makes a circuit of the track. Put a switch or two on the main line and let the other switches lead into the siding thus formed.

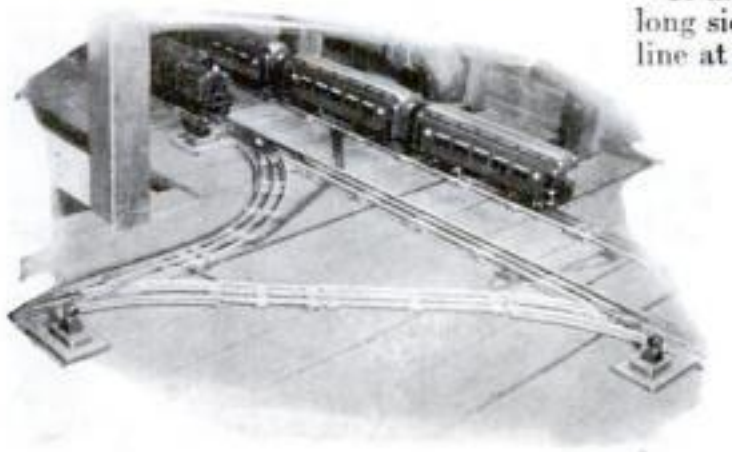
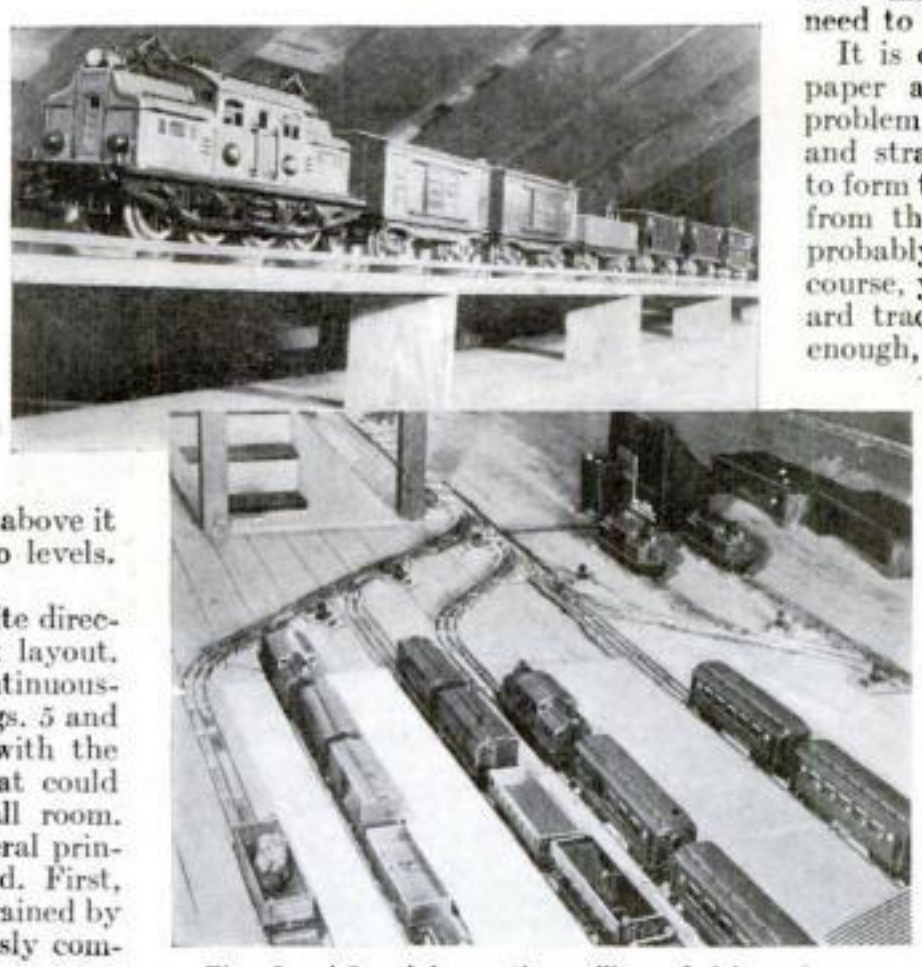


Fig. 4. Two standard right-hand switches, one left-hand switch, and shortened sections of track were used to make this Y leading from main line to terminal.

You can use a single main line around the room; or, if there is space, put in double track with not over two crossovers arranged so that you can switch the train from one track to the other no matter which way it is going.

Place your terminal where you can get at it as easily as possible to do the necessary hand operations of making up trains and handling them in sidings. Unless the room is very large, be content with one terminal and one or two passing stations located at whatever points on the main line seem most suitable.

A SINGLE switch on the main line may be used to bring trains into the terminal, but a Y will permit you to start trains off in either direction and come back into the terminal by way of the other branch of the Y. It also will permit you to turn a train without taking it off the track.



Figs. 2 and 3. A locomotive pulling a freight train up a grade of 1 in. rise in 30 in.; and a well arranged terminal.

The caution about switches on the main line does not apply to the terminal. You will find that, as your system grows, every siding you can find room for will prove useful for car storage and switching.

It also is desirable to have at least one long siding with a switch from the main line at each end so that you can hold a train on the siding while a train traveling in the opposite direction passes or so that a slow freight can get out of the way of a fast passenger express.

To start the actual plan, take a large piece of paper and mark on it the outlines of the room, using a relatively large scale. One inch to the foot will do very nicely. This will give you a fifteen-inch square for a room measuring fifteen feet in both directions. Now, with the suggestions above mentioned in mind, lightly sketch a proposed track layout. Over this light outline, draw a plan using a scale reduction for the curves of the track. Locate all the switches and track you expect eventually to install even if you don't expect to build all of it right away. Then you can work to a definite plan. Furthermore, if the plan is accurately drawn you can calculate from it how many sections of track you will need to complete each addition.

Fig. 1. To bank a curve at the end of a long stretch of track, bits of wood are placed beneath the ties.

It is one thing to draw the track on paper and sometimes a much harder problem to make the standard curved and straight track sections fit together to form the actual layout. The Y leading from the main track into the terminal probably will give you some trouble. Of course, you can make a Y out of standard track sections if you make it big enough, but to get a compact Y you will need to cut some special lengths of track.

The simplest way to lay the Y is to connect the curved end of a right-hand switch to the straight end of another right-hand switch by means of one curved section. Then take two straight sections and a left-hand switch and cut off enough of one of the straight sections so that you can line up the curve of the left-hand switch with the curve of the Y switch. Complete the job by cutting straight sections to join. A Y assembled as described is shown in Fig. 4.

There are two ways to cut track to any desired short length. One is to saw it at the desired point with a hacksaw fitted with a very fine-toothed blade. A 32-tooth-to-the-inch blade will do. This method is not as easy as it looks, however, because the thin sheet steel catches in the blade. Another method is to cut the track with a pair of tin snips and then reshape the track ends—they will have been flattened out of shape—by the careful use of a pair of round-nosed pliers.

YOU will find many places in any comprehensive track layout where cutting off a standard section will permit an arrangement that otherwise would be impossible.

The smooth operation of the locomotives and cars over the track and switches cannot be expected unless care is taken in laying every section. Be sure that every pin fits tightly. One loose pin may hinder the flow of electric current to the locomotive over a considerable section of the track and (Continued on page 117)

When and How to Apply Kalsomine

Methods, Materials, and Tools for Decorating New and Old Walls and Ceilings

By F. N. VANDERWALKER

Kalsomine is flowed on freely with a broad brush made especially for this purpose. Only one coat is necessary.

KALSOMINE may be the most suitable finish for the walls and ceilings of your home, or perhaps for the ceilings alone.

"But how can I decide that?" you ask.

Well, take the case of a new house. Usually the owner wants to occupy it at the earliest possible time. Plain white plaster walls are not very inviting, yet it is generally known that to paint new plaster immediately is risky because of so-called "hot spots," which are apt to fade oil colors and burn the life out of the oil or varnish binder, causing dead, flat looking blotches. Furthermore, new plaster is expected to settle and probably crack in places during the first winter. For these reasons it is desirable to decorate the walls and ceilings in the least expensive manner, and kalsomine serves well.

Kalsomine is to be recommended, too, when a frequent change of color is wanted, and also when it is desirable to get the decoration done in the quickest possible time. Kalsomine gives artistic, plain, absolutely flat or pastel coloring and merits consideration for that reason, aside from its inexpensive character.

ON THE other side of the account we should consider the limitations. While good kalsomine today does not rub off like whitewash and as kalsomine did years ago, it is not washable. It is applied in one coat over a size coat on either new or old walls. While you save in the first place by decorating with kalsomine, a part of what you save will have to be paid when redecorating at a later date, for the old finish must be washed off before redecorating with kalsomine, with paint, with wall paper or wall fabrics, or with lacquer.

There was a time when professional decorators mixed up their own kalsomine from whiting, glue, dry colors, and water, but little of that kind of kalsomine is used today by anyone. The bulk of the kalsomine is made in factories. After the addition of water, the dry prepared kalsomine is ready for the brush.

Prepared kalsomine can be had at any paint store in small and large packages and in one or two dozen delicate tints and shades. In a majority of cases the desired color can be selected from the color card; all you have to do is to add the water and mix up the material. When some unusual tint is needed, buy one of the available tints that is very near to what you want and then add to it a little of one of the other colors on the color card to give the exact tint desired.

New plaster of the smooth type to be kalsomined calls for little preparation aside from sizing and clipping off any splashes of plaster. It is best to cut off such splashes or fins with a putty knife rather than with sandpaper, although fine sandpaper can be used. The troweling of the plaster produces a hard glaze or shell on the surface and it is better not to cut through that if it can be avoided.

Sand-finish plaster, if new, usually requires to be swept down with a broom to remove loose sand.

Old walls having kalsomine must be well washed. Use two pails of warm water and a good sponge. Some painters first take a kalsomine brush and wet three or four square yards of the old kalsomine with water. Then the sponge is soaked and used to wipe off the kalsomine. When the sponge is loaded with kalsomine, rinse it out in one pail and wipe the wall again until the surface is clean. The final wiping should be with the clean water in the other pail, after the sponge has been rinsed out as well as possible.

If old kalsomined walls have had a varnish or gloss oil size on them, that size will not be removed by the washing and it will not be necessary to size again before applying the new kalsomine. Gloss oil size serves well enough for kalsomine, but it is decidedly out of favor, because later on it may be desirable to use paint, wall paper, or wall fabric, and none of these decorations adhere well to this kind of size. Wall paper and fabrics will not stick unless a special treatment consisting of a coat of flat paint and a size of sugar or molasses and glue is first applied. If the size under the old kalsomine was a glue size, it will be largely removed with the kalsomine, and the wall should be sized again.

Old kalsomine must be washed off before new is applied.

KALSOMINE on a sand-finish wall cannot be removed completely, but the new size coat binds in place what kalsomine is left in the low pores of the plaster. A stiff brush aids in washing off the kalsomine from a rough surface.

When papered walls are to be refinished in kalsomine, it is best for sanitary as well as practical reasons to remove the old wall paper by soaking it off with water and scraping with broad scraping knives. Occasionally ingrain and plain wall papers are sized and kalsomined, but the job is not generally satisfactory for a very long time.

Kalsomine can be applied over painted walls. If the paint is dead flat, simply size it like new (*Continued on page 111*)

Dutch kalsomine brush, scraper, putty knife, wood paddle, and pointing trowel.

You Can Make Artistic Hinges

And Other Hardware by Following the Simple Methods Described in This Article by EDWARD THATCHER, *Noted Craftsman and Teacher of Decorative Metal Work*

TO BE durable and look well, home-made hinges, handles, and key plates should be made of reasonably thick metal—the larger the piece, the thicker the metal. From Nos. 14 to 12 standard B. & S. gage sheet metal should be used for most of this work, but small hinges may be made of No. 16 gage. The metal may be copper, brass, bronze, or even mild (machine) steel, although the beginner will do well to use copper, which is strong yet softer and more ductile than the other metals.

A cold chisel is used to cut out the designs. This is one of the oldest methods, but it is none the less very effective and is usually the best way of cutting the thicker metals in the home shop.

The design is drawn full size and transferred to a sheet of cardboard, which is then cut out to form a template or pattern. Avoid, at least at first, designs with many intricate curves and angles. Simpler designs usually look much better in the long run.

When the design is ready to be cut, the metal is usually placed on a soft cast-iron block. Wood or lead blocks are not stout enough for this work, though they may be used to support thin metal. Sometimes you may find a block of cast iron at the junk yard. For small work the bottom of an old flatiron will do. Never use the face of your anvil for this work. The writer uses a square weight from an old dumb-waiter, which weighs eighty-five pounds.

The cold chisels used for this work may be of the ordinary variety, but the edges should be ground slightly rounding across the chisel as shown in Fig. 1, page 119. The reason for this is that the corners, which are apt to break off, do not receive the full force of the blow; an edge of this kind also makes it much easier to follow a curve by tilting the chisel as you cut.

Little equipment is required to make most attractive hinges, drawer pulls, key plates, and other hardware for furniture.

It is handy to have several chisels of different widths—⅛, ¼, ⅜, ½, and ¾ in., depending on the work. The smaller ones may be made by grinding down common nail sets. Professional metal workers use a chisel with an edge shaped like that shown in Fig. 2 for some curved cuts.

BEFORE you start work, see that your sheet metal is perfectly flat. Place it on an anvil and flatten it with a wooden mallet if necessary. The iron block on which you do the cutting should be placed on some solid, level surface. Set your work on it and start cutting with the cold chisel, of course using a hammer to drive it as shown in one of the photos below.

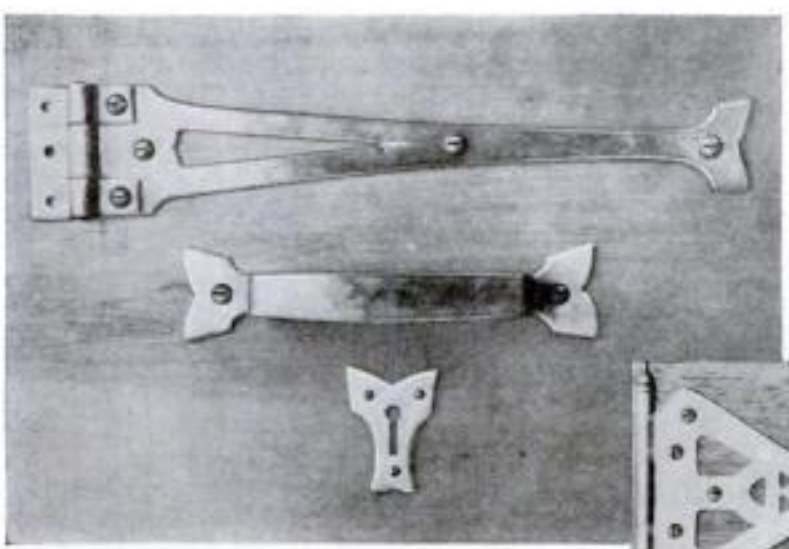
Do not try to cut through any one part at once, but go over the line lightly at first, and then go over it a second time, using heavy hammer blows. You may have to go over the line three times before you cut through the metal. As you cut through, break away such parts as are to be removed.

When parts of the metal are to be cut away inside the main outline of the work, it will save much time if you will drill a fairly large hole in each angle or corner of each space. Cut up to these holes with the chisel; and when the outline has been practically cut through, place this part of the work over a hole in an anvil and use a flat-ended punch to break out the waste metal.

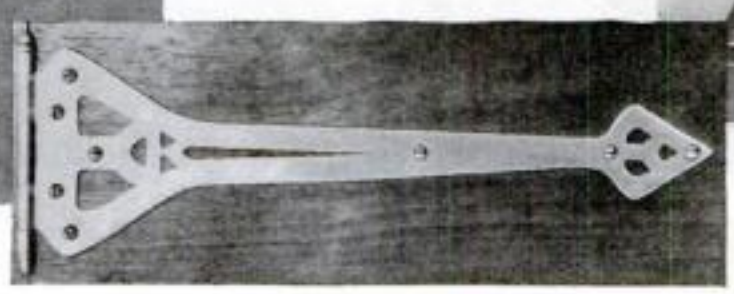
Always leave enough metal about the cut edges to allow you to file down to the line after the cutting is finished. Work made of sheet metal will look much thicker when finished if all the edges are well chamfered or rounded over, so the eye sees more of the edge.

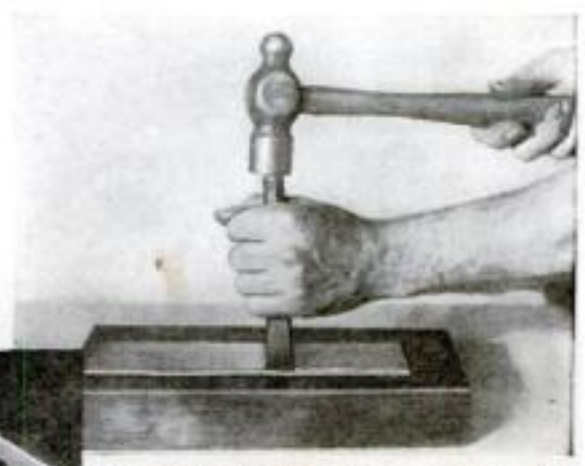
The writer most emphatically does not believe it necessary to cover each and every piece of work with hammer marks. It is quite easy to overdo the hammer marking. A plain sheet metal surface, if left on an attractively designed and executed piece of work, is often more desirable than one battered up with meaningless marks.

There are, of course, times when hammer marks certainly do add something to the appearance; then they are made with the rather flat rounded end of a planishing hammer and are of different widths and depths, with some overlapping and perhaps with an unhammered surface here and there, as (Continued on page 119)



Ornamental strap hinge of simple construction, and handle and key plate to match, all copper.





How the sheet metal is cut with cold chisel and hammer on a block of iron.

The bronze hinge at the left is a fine example of careful craftsmanship.

How to Build a *Real* Fireplace

The Trick of Making an Open Hearth Supply Cheery Warmth without Smoke Is No More of a Mystery than in Olden Days

By BASIL EWING WEBB

YOU'VE often heard it said that fireplace construction is a "lost art." In this article Mr. Webb reveals that it is more of an exact science than ever before. And he gives simple rules and measurements that will turn your dream of a cosy fireside into more than puffs of grimy soot.

"HELLO! Is this the moving man?"

"Yes, ma'am."

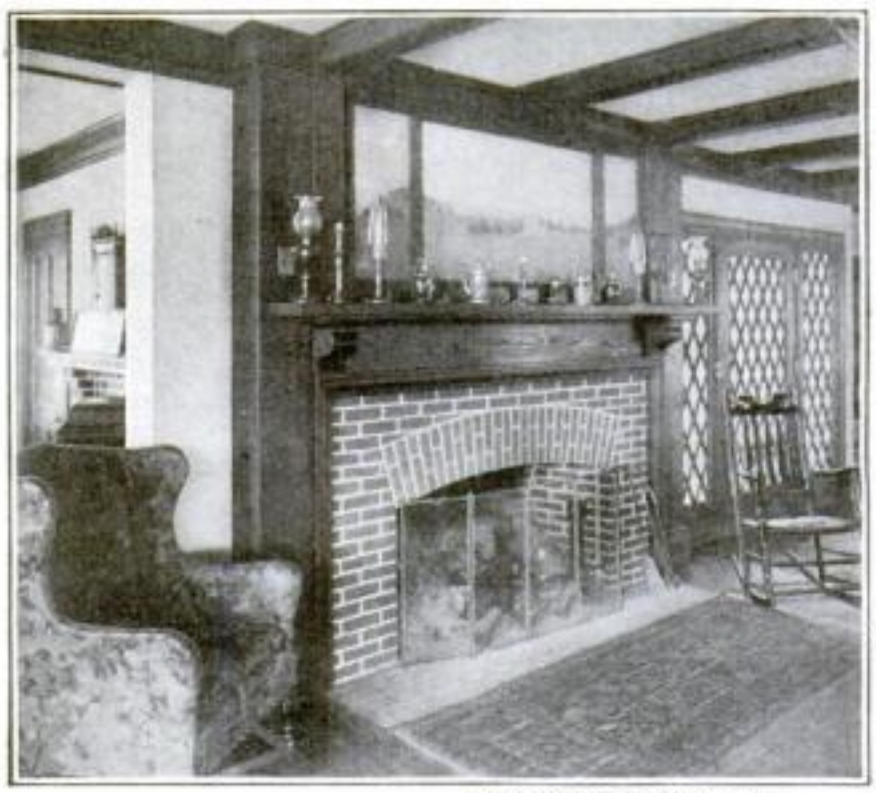
"Well, I am Mrs. Whyte. I want to be moved tomorrow. Please be very careful in handling the parrot, the goldfish, and the open fireplace—"

"The what, ma'am?"

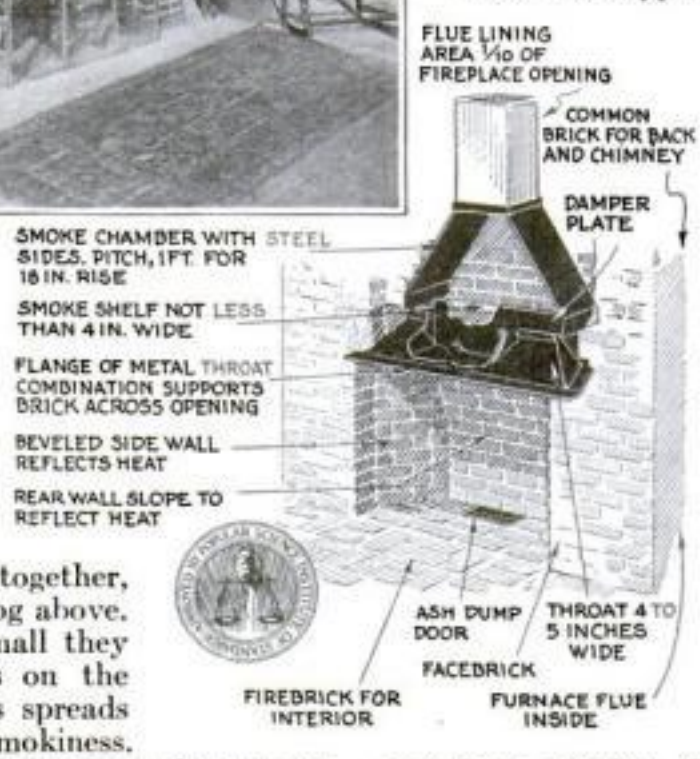
"Open fireplace! It belongs to us, so of course we take it along when we move. It looks like brick but it's made of tin or something so it is easy to lift, but it can get dented. A grate full of red-hot coal goes with it. You understand the coal is really not red-hot because it is not coal but only seems to be, which is very cheering on a cold winter evening."

"All right, ma'am. We'll try *not to burn our hands.*"

The giddy-minded laugh over such a tale, but the old-timer groans despondently and says the American hearth has become stage "hokum." He bids us recall the genuine fireplace of our sires, noble and massive, wherein a sheep or quarter of beef could be roasted, that heated the whole house and was the proper center of the home.



The one fault of this fireplace is its front screen. It should cover the entire opening, curving inward at the top, to keep sparks from flying into the room or up to the wooden mantel. In the diagram at the right are revealed the most important points to be observed in the correct construction of a fireplace.



But let the old-timer cheer up. Make-believe masonry and imitation fuel have not yet routed the real article by a long shot, even though the fireplace has indeed lost much of its ancient utilitarian value in cooking and general heating.

TRUE, tests have shown that an open grate burns seven to ten times as much coal as a steam boiler to produce equal temperature in a room. Most of the fireplace heat flies up the chimney. But it is unfair to condemn the fireplace because it cannot wrestle against zero weather. It shines on cool days in spring and fall when the furnace is not going. It removes the chill mornings and evenings. It toasts the shins while it gladdens the eye. It emits salutary heat rays which no radiator or register supplies. Thus we derive health as well as comfort from the crackling logs or glowing coal.

When fireplaces smoke it is usually because they are not built in the right way. But sometimes the fault is in the chimney or in improper stoking. If you pile up a large mass of green wood and try to burn all of it at once, no flue will carry off the volume of smoke produced. It is a good rule to keep the fire in the center. Put a log on the andirons at the back, burn it in two, place the pieces together, and set another log above. If the logs are small they burn well in pairs on the andirons, but this spreads fire and tends to smokiness.

If a good sized fireplace throws out only a little heat, this is because the back and sides are straight, so that the heat shoots up the chimney instead of being reflected into the room. Few masons today know much about fireplaces. One might think there was a mystery and a lost art involved. Perhaps the mystery is that intelligent owners do not take a few measurements to see whether the simple rules of right construction are followed.

A FEW simple rules enable anybody to check up right construction. If the width of opening is thirty-two inches, the height should be twenty-eight inches and the depth seventeen to twenty-one inches. If the opening is three feet wide, a couple of inches may be added to height, while the depth remains twenty-one inches. A width of four feet requires height of thirty-two inches with a depth between twenty-one and twenty-five inches. The inner sides of the fireplace should be slightly beveled to reflect heat into the room, and for the same reason the rear wall should slant forward, starting about a foot above the hearth level. We do not have to figure the amount of pitch when we use, as is preferable, a ready-made cast-iron throat with damper. Let the slope meet the bottom of the throat, and by using a wooden form set at this angle anyone can lay the bricks to make a smooth uniform slant. The rear slope is more important than the side bevel and should never be omitted.

The iron throat combination is made to support the top of the fireplace opening. This obviates the old-time metal bar or arch construction. The iron throat should extend the full width of the fireplace opening, and its own width should be four to five inches. A damper of the chain, worm gear, or lever type allows variation in the smoke outlet, according to need, with total closure in summer to keep insects from entering. The damper is also useful in winter when the fireplace is not in action to keep cold air from descending the chimney and refrigerating the room.

Chief essentials of an effective fireplace are a smoke shelf and chamber. The shelf is a flat stretch of masonry

A massive stone fireplace. Since stone is less fire resistant than brick, the walls should be twice as thick, or at least sixteen inches.

built along the back of the throat top, of the same length and not less than four inches wide. It serves to baffle the back-draft of smoke that normally slides down the rear wall of a chimney and throws it into the strong up-current of gases. The back-draft is rather weak and can be thus diverted by a shelf at right angles to its course. But if the shelf is missing or is mistakenly sloped downward, the back-draft keeps sinking and some of it enters the room, with smoky consequences. The smoke chamber is a space naturally formed by the gradually narrowing walls to connect throat and shelf with the flue. It is larger at the bottom than the top and acts as a reservoir to hold surplus smoke for a moment when gusts of wind tend to seal the chimney outlet; also when green fuel suddenly belches a large volume of smoke. The recommended pitch of the chamber is one foot for eighteen inches of rise.

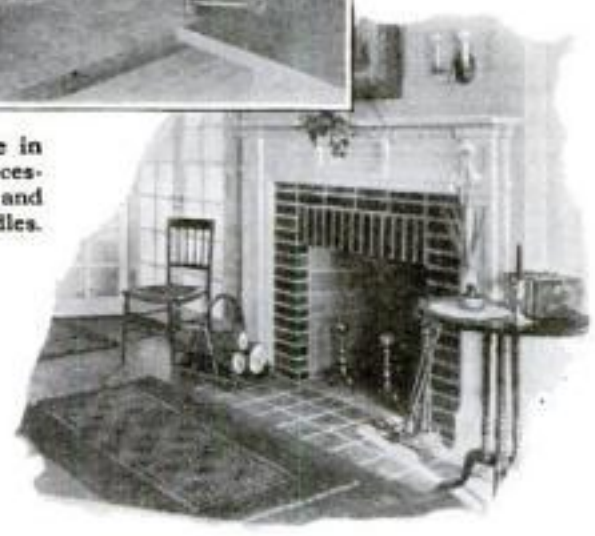
SMOKE chambers can be obtained ready made, and they are worth getting, both to simplify the job and to insure first-class results. The ordinary practice is for the mason to narrow the walls with layers of bricks in steps, which makes a rough, jagged interior with much friction and turmoil for ascending smoke. Smooth walls are almost as desirable for conveyance of gases as for water; they increase capacity and reduce back pressure. So it is an advantage to have a ready-made chamber, of metal or reinforced concrete.

The chimney flue should be one tenth the area of the fireplace opening. For example, the area of twenty-eight-by-thirty-two-inch opening is 896 square inches, of which one tenth is eighty-nine. We select a flue lining eight by twelve inches, since this is the nearest size available. While the most efficient flue shape is round, or elliptical, it is difficult to obtain such shapes and the ordinary square or oblong types are easier to install. Be sure that fire clay flue lining, not drain tile, is used and that it extends the whole distance to the chimney top. Space between lining and brickwork should be packed tight with mortar. Each length of lining should be well fitted to the one beneath. The flue should serve the fireplace only, no other intake from furnace or stove being permitted.

It is often possible to correct an old fireplace that is faulty. The dimensions of the opening can be reduced. If the height is too great, raise the hearth with a layer of fire brick in mortar or with concrete reinforced with wire mesh. The same end may be accomplished by lowering the top, having an angle iron across to support a line of new bricks. It is simple to reduce width or obtain beveled sides with bricks and mortar. Bricks can be cut to angles with trowel or cold chisel. There is more of a job in giving the rear wall a forward slope that will stay put. Concrete reinforced with heavy wire mesh attached with expansion bolts to the old wall may serve, but it is better to use bricks with frequent anchorage of expansion bolts. And before starting work on an old fireplace, the interior should be thoroughly cleaned with a wire brush and scrubbed with washing soda. A sooty surface filled with creosote does not invite mortar to take hold.

The interior of a fireplace should never be lined with common brick. Special fire brick must be used. These are made of clays that resist great heat. Furthermore, the lining bricks should not be laid sidewise to expose their width, but in the manner that shows the sides, since in the former case the lining is two inches thick compared with four inches in the latter. It is all right to use common bricks beyond the lining and for the entire chimney above the fireplace. To combine looks, safety, and economy, use face bricks for the exposed outside of a fireplace, fire bricks for lining the inside, and the common variety of brick for the rest.

The fireplace in an old-time farmhouse in Massachusetts. Its large size was necessary to supply not only heat for cooking and comfort, but light to supplement candles.



A well-constructed fireplace for a small home. Note the interior built of fire brick, made of special clays that resist tremendous heat.

IN RESPECT to thickness the side walls usually take care of themselves. One of them contains the furnace flue with a casing of one width of brick, which totals not less than sixteen inches of thickness in front, with an increase toward the back due to bevel. The other side wall matches for the sake of symmetry; it is often built hollow but might well be filled with brickbats and mortar. The back wall has surplus thickness at the slant, for the space between it and the vertical exterior is or should be filled with solid masonry. The danger point is along the foot-high vertical part of the wall below the slant, which usually is two bricks, or eight inches, thick. A long-continued wood fire will make the outer brick on this vertical too hot for the hand, which is a token of hazard. If flooring or a beam beneath touches this superheated masonry there is a slow charring of wood that prepares the way for a conflagration. The ominous process may go on for months and years with the final act of ignition due to crumbling mortar joints, or oily rags, paper, or rubbish in contact with the brickwork.

An extra thickness of a foot or so makes the vertical back wall that much safer. However, the fire underwriters approve the lesser thickness provided that no woodwork, whether flooring or beams, comes within two inches of the sides and back.

This two-inch space is to be filled with loose incombustible material, such as asbestos or mortar rubbish, supported on a metal strip nailed to beams. A similar insulating space is required around the chimney at the second floor and at the roof. The old-time practice of framing beams into a chimney is strictly prohibited. It involves both fire (Continued on page 159)

Though a fireplace is wasteful of fuel, burning nearly ten times as much as a furnace to produce the same temperature, yet the cheery blaze of its logs adds comfort and beauty to any home.

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The Driving Force That Wins

TWO articles in this issue drive home the same point. One tells of Hugo Eckener, master mariner of the sky. The other begins a series about Wilbur and Orville Wright. Eckener was a mature man, with a reputation as an economist and a writer, when he interviewed Count Zeppelin and became interested in the possibilities of airships. The Wrights were small-town Ohio boys, who never completed their high-school education, but made the airplane possible.

At first glance, there seems to be slight resemblance between the careers of these men who have made history in two phases of aviation—which, with radio and the automobile, promises to change the customs and habits of the world. When they began their work, the main resources of both Eckener and the Wrights were imagination and enthusiasm. Neither had the benefit of specific training for the work they set out to do. They succeeded, nevertheless, in highly technical fields.

Lack of training can be remedied; lack of imagination and enthusiasm cannot. Imagination pushes the mind forward and enthusiasm is the driving force. Progress in science, and in everything else, must have these two qualities for its foundation.

New Ways to Make a Million

ROGER BABSON, business statistician, lists seventy opportunities to become a millionaire. Among others he mentions watches run by radio, self-finding golf balls, precast tunnels, volcanic power stations, automobiles that can run sideways for parking, and a method of changing birch into mahogany. Some day someone will seize every one of these opportunities.

Wonders of science are following each other so rapidly these days that we can even speculate on the possibility of instantaneous transportation of physical substances from one place to another. Think of what it would mean to be able to step into a transmitting apparatus in New York and be able immediately to walk out of the receiving mechanism in London without having to resort to ships or airplanes. Of course there isn't a single scrap of evidence to indicate the possibility of any such marvelous development, but the "impossible" has been accomplished many times.

It was not so long ago that Edison's phonograph, presented to the French Academy of Sciences, was denounced as "impossible, a rascal's trick of ventriloquism." And in 1843 an official of the United States Patent Office resigned because "it is impossible to discover anything new and it is only a matter of months until this office will be forced to close through lack of business." Careful people prefer the words "improbable" or "unlikely" to "impossible."

When Editors Miss the News

A REFRIGERATOR-FURNACE capable of either cooling or heating a house is being developed by the American Gas Association. This announcement was hidden in three lines on the inside page of a great newspaper. Displayed prominently on the front page of the same paper was the story of an obliging hen in a Kansas town that walked into a farmer's pantry and laid an egg in the egg crate.

There are 300,000,000 hens in the United States. One made the front page because it did something different. The man who sits for days on a flagpole or goes over Niagara Falls in a rubber ball makes the front page for the same reason. The scientist who makes a valuable discovery also does something different, but he does something that benefits every one of us. However, he doesn't always make the front page. Some day, perhaps, all newspaper editors will realize the importance of scientific discoveries.

We Need a New Calendar

OUR present calendar, with its twelve months of unequal length, is like a yardstick that sometimes measures thirty-six inches and sometimes thirty-eight or thirty-nine. Movements for calendar reform have been frequent and unsuccessful in the last quarter of a century. Now, however, business men are beginning to interest themselves in the idea. Mr. George Eastman, of Kodak fame, for example, supports a proposal to divide the year into thirteen months of twenty-eight days each, every month beginning on a Sunday and ending on a Saturday.

Mr. Eastman is right. The business advantages of a year having thirteen months each of four equal weeks are apparent. POPULAR SCIENCE MONTHLY frequently has pointed out the need of such a change. Thirteen monthly settlements instead of twelve would mean a faster turnover, a larger volume of business with less capital. Month to month statistical comparisons would need have no adjustments for an unequal number of days or weeks. Each year, month and week would begin on a Sunday and end on a Saturday. For everybody all calculations of income and expense would be simplified.

Easter could be given a fixed date to the advantage of many businesses. Holidays such as Christmas, New Year's, Washington's Birthday and the Fourth of July would come each year on the same day of the week. The extra month, called "Sol," would be put in between June and July, and the 365th day, called "Year Day", added as an extra holiday between December 28th and January 1st. The calendar, the same for each month, would look like this:

Sun.	Mon.	Tue.	Wed.	Thu.	Fri.	Sat.
1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28

The suggestion meets opposition, for one reason because the thirteenth would always fall on Friday. But it will take more than superstition to kill the proposal.

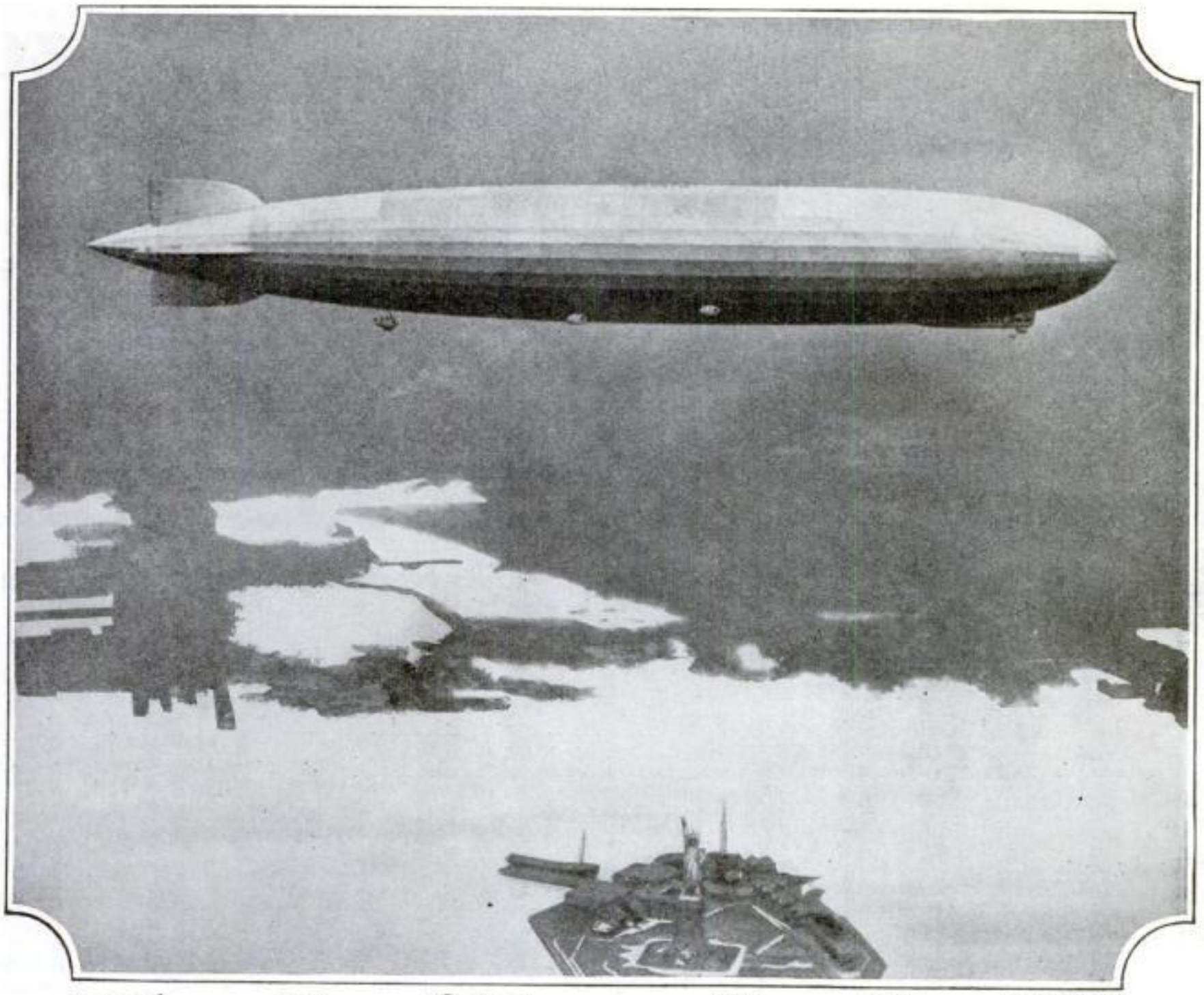
They Are Saying—

"TWO big captive balloons, hoisting between them a glass-inclosed platform high into the sunshine, can cure all the tuberculosis in Northern Russia."—Prof. H. Opel, Director, Mechnikoff Hospital, Leningrad.

"Unless the frenzied efforts of young women to become slender are checked, there will be a marked tubercular increase."—Dr. Bertram L. Bryant, Sec'y, Maine Medical Association.

"There is a direct connection between the weather conditions in the Antarctic and the rise and fall of the River Nile."—Capt. Sir Hubert Wilkins, explorer.

"Popularizers who bring an understanding of science and academic investigations to the people have an important place in civilization's advance."—Thomas A. Edison.



(P & A Photos)

The Graf Zeppelin Comes Across on 465 SKF Bearings

A GREAT, gray monster of the skies, lighter than the air its giant propellers thrust astern, pushes its nose through the autumn sea-mists and hangs suspended for a moment above a great city, as though making its curtain call and taking its share of well-earned applause while millions of upturned faces register their appreciation of the fact that another page has been written in the history of passenger transportation.

An entire world had waited while the five great Maybach Motors sang their songs of progress across the great Atlantic wastes—a world afraid as that other world of 1492 must have been afraid when three caravels cleared the Port of Palos and pointed their prows toward a new and unknown world. And yet, in the one hundred and more cities throughout the world where SKF offices are located there was a feeling of hope, of confidence, of belief.

Had not Lindbergh made his historic flight with the help of SKF Bearings? Didn't they help to carry Chamberlain to Germany, Byrd to Ver-Sur-Mer, Maitland and Hagenberger to Honolulu?

Weren't they on the Los Angeles when she flew on her maiden voyage to America?

And were there not four hundred and sixty-five of these same SKF Bearings in the motors and in the other mechanical parts of the Graf Zeppelin?

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"THE HIGHEST PRICED BEARING IN THE WORLD"

How You Can Test Antifreeze

"Paste this in your hat," Gus suggested. "A glycerin solution that floats this particular hydrometer at 1,080 will keep Jack Frost out of your radiator down to ten degrees."

Gus, Turning the Model Garage into a Laboratory, Works Out Easy Formula for Radiator Solutions

By

MARTIN BUNN

"SOME people," grumbled Gus Wilson, "sure do waste a lot of time finding out what they want to know."

The veteran auto mechanic disgustedly shoved the telephone away from him.

Joe Clark, his partner, who had called him into the office of the Model Garage to answer the phone, grinned sympathetically. "What did that bozo want?" he inquired. "If I'd known he only wanted to ask a bunch of fool questions, I wouldn't have bothered you."

"Funny you didn't recognize him," replied Gus. "That was old Dexter, the bird who's always spouting theoretical stuff about calories, thermo-something-or-other, and the rest of it. He'd rather mess around for hours with a pencil trying to figure out something than to ask someone who knows."

"Then what's he pestering you for?" Joe asked. "Why don't he figure it out if he's such a shark at it?"

"He didn't ask any questions," grunted Gus. "He says he's coming here to get me to help him on some of his blasted calculations. I didn't get what he was driving at except it had something to do with specific gravity. I just told him to come ahead and I guess he's on his way now."

A FEW minutes later Dexter drove up and insisted on bringing his car inside instead of parking it in front of the garage. It was below freezing outside, he explained, and he was afraid the radiator might freeze.

"I am sorry to bother you, Mr. Wilson," he said, as he reached into his car and dragged out several thick and musty looking scientific books. "It is just a relatively simple problem in specific gravity. That is, it should be simple enough, but there are several confusing factors that complicate matters."

"What are you trying to do, figure out what makes ice float?" smiled Gus.

"No," replied the other. "You recommended that I use glycerin in the radiator this winter and I took your advice. The results have been excellent until day before yesterday, and then I unfortunately forgot to open the radiator shutter until the motor became so overheated it began to boil, and I am afraid that a large part of the solution squirted out the overflow pipe with the steam. Now I don't know what actually is left in the radiator. I looked up the specific gravity of glycerin and found it was 1.265 degrees at ordinary temperatures. It occurred to me to calculate the specific gravity of the mixture I was using and then by test see what I actually had. But these books show that it is rather complicated."

"BUMPED right into a tough one, didn't you?" said Gus. "Seems to me I remember reading some place that 'a solution is a uniform mixture that doesn't follow the law of definite proportions.' That floored you, eh?"

"That's it precisely," said Dexter, "and now I am unable to find a formula to fit the case. Perhaps you can help me?"

"Sure," Gus replied. "Chuck those blame books back in the car. We won't need 'em. Hey, Bill!" he called to the youngster who was sweeping the other side of the garage. "Chase yourself down to the drug store and buy me a couple of ounces of glycerin and a test tube. Make it snappy!"

"Now," Gus explained when Bill returned a few minutes later, "all we've got to do is to take the hydrometer float out of this storage battery hydrometer and see how it floats in different mixtures of glycerin and water. What's the matter with that way of finding out what you want to know?"

"But will the results be sufficiently accurate?" Dexter objected doubtfully.

"Why not?" countered Gus. "You could wear out a couple of pencils figuring it closer than the paper on the wall, and even then you wouldn't be dead sure. These cheap hydrometers are no great shucks for accuracy. Your figures might be all right and a bum hydrometer would throw you way off. But if you make up the actual mixtures and float a hydrometer in 'em—any old hydrometer—you can keep that hydrometer just for testing your radiator solution, can't you?"

"You've proved your case," admitted Dexter.

"THESE storage battery hydrometers," Gus continued, "don't read much below 1,075, so you won't be able to tell anything about very weak solutions of glycerin and water. Let's start with one part glycerin to two parts water. That's a thirty-three percent solution."

"Reads about 1,080," said Dexter, bending over to get his eye on a level with the top of the solution in the test tube.

"Paste that in your hat," Gus suggested. "A glycerin solution that floats this particular hydrometer at 1,080 will keep Jack Frost out of your radiator down to about ten degrees."

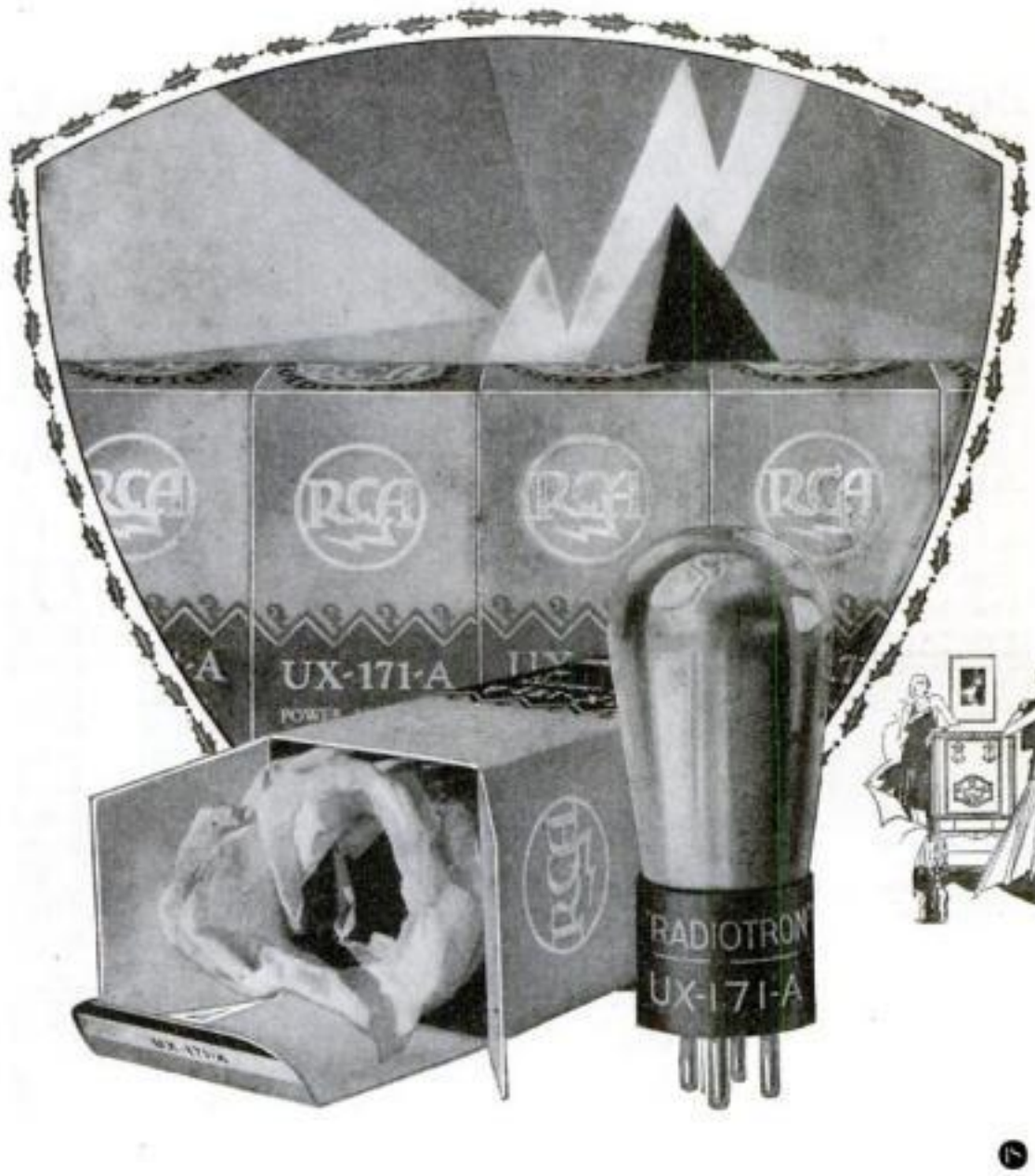
"But we occasionally have colder weather than that in this latitude," Dexter objected.

"Sometimes," agreed Gus. "Let's see how it reads in a forty percent solution. That won't freeze down to zero. And if we add one third of a part more glycerin to what we've got in the test tube already we'll have mighty close to a forty percent solution."

DEXTER did a bit of figuring while Gus was stirring in the added glycerin and found that the auto mechanic was right.

"There you are," said Gus, as he jiggled the test tube to make the hydrometer float without sticking to the glass walls. "Just 1,100 on the scale. Nice easy figures to remember. Keep the solution at 1,100 if you want zero protection."

"Excellent!" Dexter exclaimed. "Now I have merely (Continued on page 154)



A Kit of Ideas for Motorists

If the Fan Belt Breaks, or You Need Tire Chains in a Hurry, Here's the Remedy—And Some Other Handy Kinks

NEGLECT to carry a trouble light in the tool kit of the car may cause no end of annoyance on the road at night in the event of some minor difficulty. However, often it is possible to obtain all the light necessary for a small repair on the ignition system or the carburetor by using a small hand mirror to reflect the beams from the headlight to the desired point. If no hand mirror is available, unscrew the rear view mirror and use that.

If you have no trouble light, one can be improvised by using a small hand mirror to reflect headlight beams.

Snow Hooks of Hose

WHILE chains of the ordinary type usually will give you traction in snow or mud, it is a dirty job to apply them. And when most of the route is clear, with only a short section of road in bad shape, chains will come in for a lot of unnecessary wear besides chafing the tires.

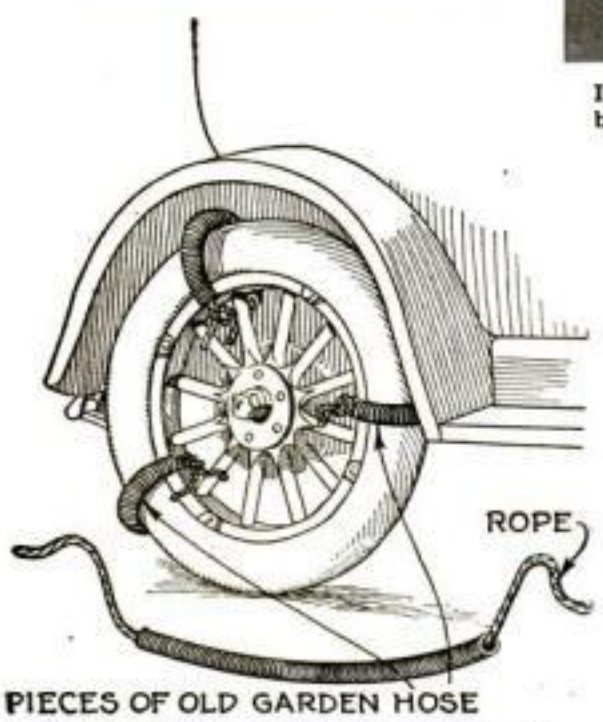


Fig. 1. Emergency tire chains made by threading rope through hose and tying on.

Fig. 1 shows a simple solution of the problem. Take pieces of old garden hose and through each piece pass a length of strong rope. When you reach the bad place in the road it is the work of but a few moments to tie them in place as shown. They can be removed with equal facility when the bad part of the road is left behind. Pieces of hose attached in this way are particularly effective in deep, soft snow but they are, of course, no good on ice, where ordinary chains should be used.

Three-Tone Horn

THE note produced by one type of auto horn depends on the voltage applied to it. If your horn is of this type you can make it sound three different notes by the use of resistances and buttons wired as shown in Fig. 4 at the right.

Two rheostats such as are sold for use in building radio receivers can be used. As you will note from the diagram, pressing the right-hand button allows the current to flow unimpeded to the horn mechanism. Pressing the center button places the resistance of one rheostat in the circuit, and pressing the other allows the current to flow through the second rheostat. The horn mechanism may require slight adjustment for best results. The resistance of the rheostats will depend on the current drawn by the horn and how much resistance is needed to cause the required change in tone.

Ten Dollars for an Idea!

August Grosze, of Collinsville, Ill., wins this month's $10 prize for his suggestion of a novel bushing press (Fig. 2.) Each month POPULAR SCIENCE MONTHLY awards $10, in addition to regular space rates, for the best idea sent in for motorists. Other contributions used are paid for at the usual rates.

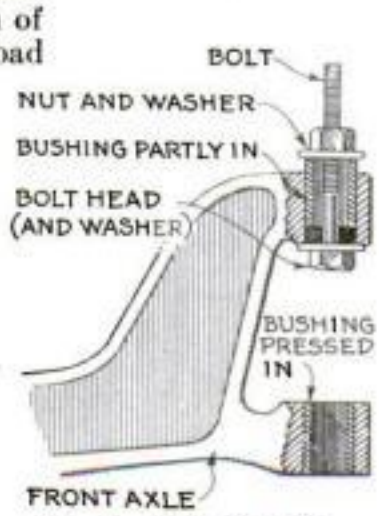


Fig. 2. Bolt, nut and washers are used to press on a king-pin bushing.

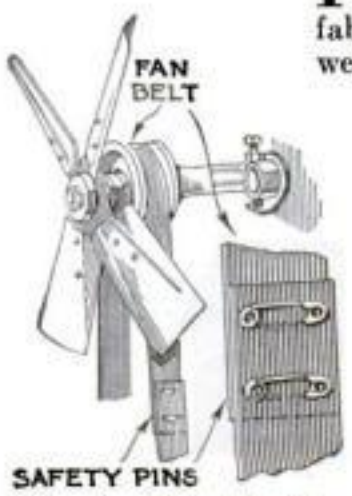


Fig. 3. Fan belt repaired by joining broken ends together with pins.

Novel Bushing Press

ONE bolt, one nut, and two washers will permit you to press king-pin bushings, or any similarly assembled bushing, into place just about as well as it can be done in an arbor press. And there is no risk of deforming the edge of the bushing, as there would be if you pounded it into place. Fig. 2 shows the method.

The bolt should be a loose fit through the hole in the bushing, and the washers should be somewhat larger than the outside diameter of the bushing. If the washers are thin, use two or three at each point.

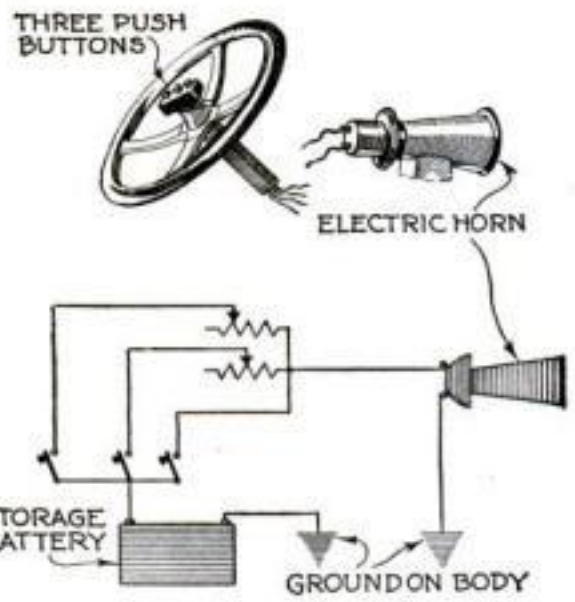


Fig. 4. This diagram shows how to wire horn to produce any one of three tones.

Fan Belt Repair

IF YOUR auto motor is equipped with a plain, flat fan belt made of either fabric or leather, it is possible to repair it well enough to get to the nearest service station. You will have to loosen the belt-tightening adjustment to obtain the necessary slack so that you can overlap the ends, and fasten them together with safety pins, as shown in Fig. 3. If that is not possible, you can pin a thin piece of leather to the two ends to hold them together.

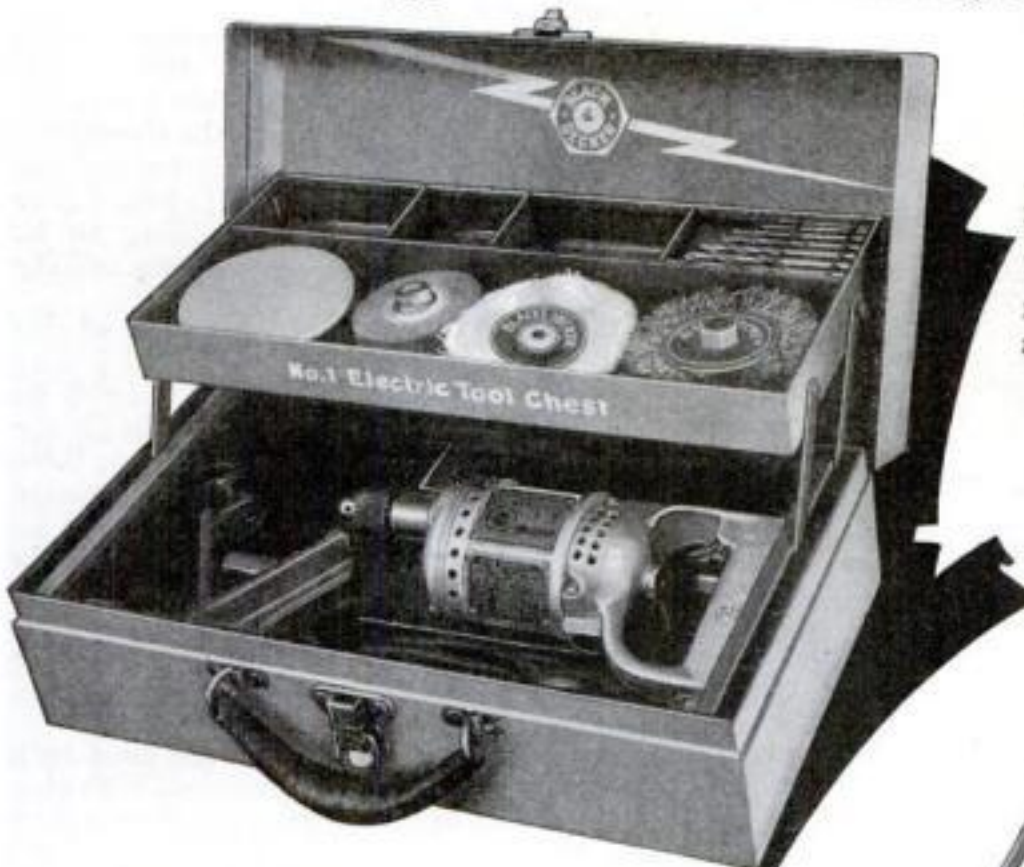
If the distance to the service station is not too far, tying the ends together with a strong cord may serve as an emergency repair. The belt should be replaced with a new one as soon as possible.

BLACK & DECKER

Electric Tool Chests

For drilling holes in—Metal, Fibre or Wood—or any material which can be cut with an ordinary hacksaw. For light grinding, buffing or sanding.

Everything at your finger tips when you want it. The automatic tray, which contains the accessories, is sealed tight by the cover when the chest is closed, so that in any position the contents of the tray cannot spill out or get mixed up.



No. 1 Electric Tool Chest

A heavy metal tool chest containing—

Black & Decker Light Duty Quarter-Inch Electric Drill; Bench Stand for light grinding, buffing and sanding; set of twist drills up to 1/4 inch, wire wheel for rust and paint removing, rag buffing wheel, grinding wheel, and sanding disc.

U. S. Price, $43.50
Canadian Price, $56.50

No. 4 Electric Tool Chest

The same type of chest as the No. 1 but considerably larger. Contains—

—the famous *Black & Decker* Half-Inch Special Ball-Bearing Electric Drill, twist drills from 1/4 to 1/2 inch, wood augers from 3/4 to 1 1/2 inches and *Black & Decker* hole saws from 1 3/8 to 3 inches. The hole saw is a special *Black & Decker* tool for use with the electric drill, enabling you to bore holes in metal, wood, fibre, etc., up to 3 inches in diameter.

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This is the electrical age. With a Black & Decker Electric Tool Chest you can do better and faster work. Own an Electric Tool Chest and be up-to-date.

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Setting Up a Bench Saw Table

How to Build a Rigid but Easily Moved Machine Support with a Belt Tightener and a Dust Chute

By W. CLYDE LAMMEY

THE saw table support illustrated is designed to overcome some of the ills attendant upon the operation of a bench saw driven by a separate motor. Where such an outfit—now to be found in many home workshops—is mounted on a heavy plank or the like, it is difficult to move the assembly about the shop, to prevent the belt from slipping, and, if the table has the tilting feature, to place the saw so that long stock will clear the bench when cutting angles.

A satisfactory home workshop saw rig requires some means of tightening the belt quickly and effectively without having to loosen the bolts holding either motor or saw frame; a mounting that is absolutely solid and permanently rigid, especially that part supporting the motor (for a firm base will eliminate injurious vibration and add years to its life); and an arrangement of parts that is economical of space.

Having these essentials constantly brought to mind in his work, the writer set out to build a mount that would embody the required features. Several mounts were constructed and discarded after considerable experiment. The principal drawback of all these attempts was the manner of mounting the motor.

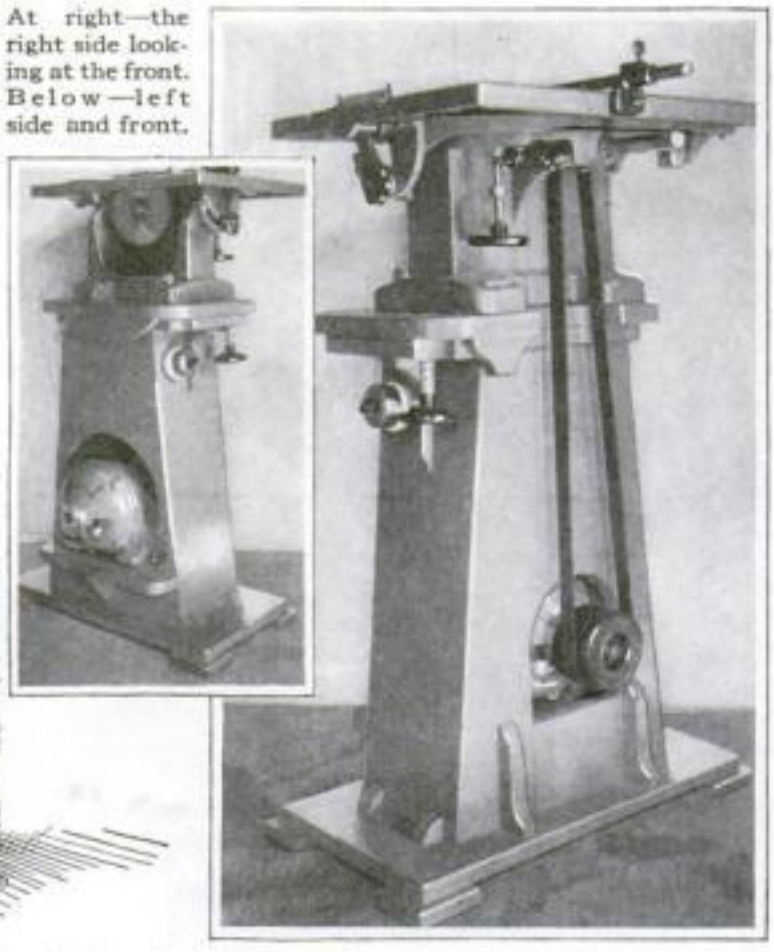
The final arrangement is in essential that shown in the accompanying drawings and photographs. It worked so well from the beginning and filled all the requirements for the satisfactory operation of a bench saw table in such a gratifying manner that the statement is here ventured that any man who owns a bench outfit driven by a separate motor will find a notable improvement in the capacity of his saw if he will take the time to construct a mount after this fashion. The entire cost of the mount, including brushing lacquer finish, was found to be less than three dollars.

THE motor is fixed permanently on a solid, immovable support yet may be removed when desired. The floor space occupied is but 16 by 20 in. The sawdust is delivered through a chute to the back of the machine, where it may be caught in a bag. The outfit is easily moved, as it rests on sliding casters; and, owing to the distribution of the weight, it will not tip either way. Disagreeable vibration is eliminated. Lastly and most important of all, the belt tension is always adjustable, even when the machine is running, by the action of a conveniently located handwheel.

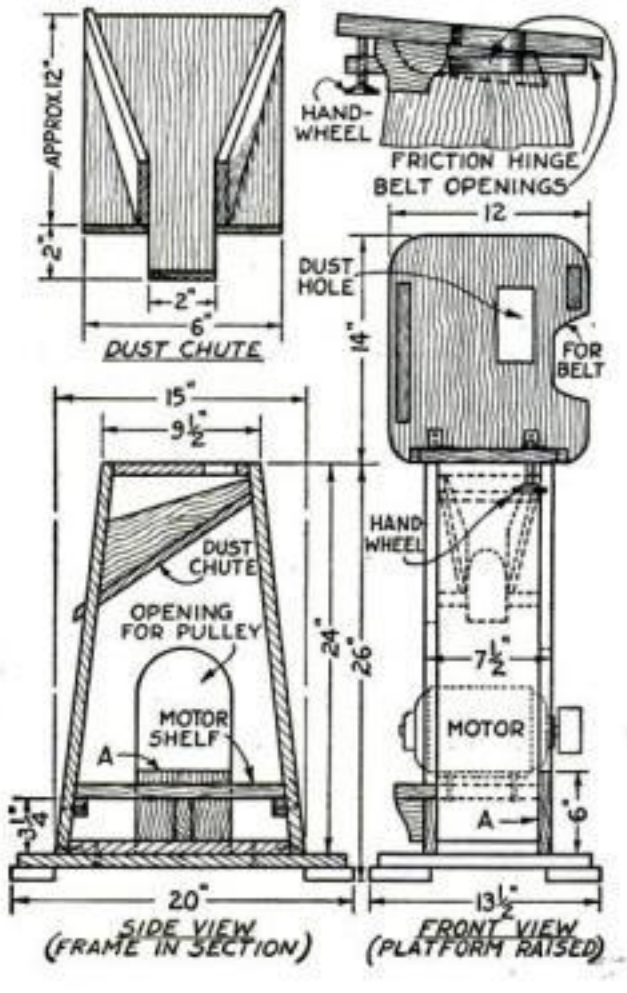
The drawings should be sufficient for any handy man to work from. If any one feature of the construction requires further comment, it is the care necessary in fitting the separate parts. Only simple butt joinery is called for, but unless the surface fits true and tight the strength of the glue is largely lost and the joints are likely to loosen after a time—a possibility to be guarded against when solidity is the main virtue.

A liberal application of glue should be used on all joining surfaces save the 6 by 6 in. piece marked *A* and also the one marked *B* on page 104; these are fastened with screws only as provision must be made for removing the shelf. When in position the support is held rigidly by screws. Flat-head 1¾-in. screws are used, the heads being countersunk flush.

At right—the right side looking at the front. Below—left side and front.



Above are two photographs of the saw table and mounting which show its compactness and neatness; below are drawings of the construction.



THE dust chute must be a close fit, secured with glue and screws at a sufficient slant to facilitate the escape of the sawdust and chips from the dado head, if one is used. The dust opening in the platform shown in the drawings should be located to suit the saw and should be smaller than the opening in the fixed portion below, so that a piece of heavy tin neatly tacked in the upper opening will conduct the dust into the chute without allowing it to get between the hinged pieces when the platform is raised.

Attention is called to the center support under the motor shelf, which extends clear through; it should be a good fit and well glued. This thwarts any tendency to spring under the motor's weight and prevents lateral vibration.

Before fastening the sides of the column, it is well to level a place on the floor both ways with the spirit level, place the mount upon it, and level the motor base true with the top which is to support the platform, planing out any discrepancy.

In the upper right-hand view of the drawings on this page showing the handwheel, the dotted line is the apron on the opposite side of the platform. This longer apron is shown in position on page 104. These aprons, which fit fairly tight over the fixed piece of the hinged part, are to prevent any side sway when the platform is raised.

Two fairly heavy friction hinges are used. These must be let into both pieces with some care (*Continued on page 104*)

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There are 25 Stanley Plans: boats, dog houses, tables, chests, work benches, etc. They sell for 10c each at your hardware dealer's. There is, also, our new book "How to Work with Tools and Wood". Your hardware dealer has this, too. You can get it for $1.

On the left are three typical Stanley Tool Chests. There are 16 altogether, ranging in price from $5 to $95. Ask your hardware dealer for catalog showing them all. Or write to us for a free copy of Catalog No. Se35. The Stanley Works, Advertising Department, New Britain, Connecticut.

STANLEY TOOL CHESTS

The all-year-'round Xmas gift

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 12.

How to Build a River Packet

Captain McCann used plywood in building up the texas, but cardboard will serve as well.

You Can Begin Now to Construct the Latest Type of Ship Model, Even if You Missed Our Preceding Articles About the Buckeye State

By E. ARMITAGE McCANN, *Master Mariner*

IN TWO previous articles we described how to make the hull and many of the fittings of the stern-wheeled *Buckeye State*, a passenger and freight Mississippi steamboat of 1878. Those who missed these issues, yet wish to build this picturesque and now most popular type of model, need not hesitate. They can obtain the two back numbers of the magazine (November and December, 1928) by sending 50 cents to POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City, and, what is more important, for seventy-five cents they can get three blueprints which contain full size drawings of the finished model and views showing it at various stages of the construction. These blueprints are Nos. 94, 95, and 96 on the list on page 105.

Herbert and Edward Quick in their book *Mississippi Steamboatin'* have a good word for this class of craft:

"These steamboats were the craft that seamen sometimes called derisively 'Steam engine on a raft.' Without doubt their low flat hulls and towering upperworks looked queer and unsubstantial to a sailor's eye. But the steamboat at her finest was the product of a long line of evolution. She was developed to meet a set of conditions and needs and disappeared only when the conditions changed and the needs were met by other conditions. The steamboat carried the freight and passengers and she carried them fast. She was beautiful with the beauty of a thing that fulfills its purpose well. In her own way, her lines were as trim and clean as the lines of a yacht. And her speed would compare favorably with the speedy water transport of today."

Our particular boat was a smart one with her speed of fifteen miles an hour in dead water. The *Eclipse*, which was the fastest river boat ever built, had a speed of sixteen miles upstream and twenty-five miles downstream, but she was one of the racing side-wheelers. Though our boat had not so much wood scroll and fancy work as some (for which we may be thankful), she was about as typical as possible of a class that started in 1813 and still continues.

Our model has now progressed to the point that its deck fittings are in place. The next thing required is the boiler deck. I made mine of ⅛ in. thick holly wood, but any other light colored wood will do, such as birch or pine. It might even be made of heavy cardboard such as five-ply Bristol board, or two thinner sheets glued together; if that is used for the decks, they should have for stiffening some wooden crossbattens, placed underneath where they will not interfere.

Cut the deck, which is 3½ by 16⅛ in., to the outline shown on the deck plan reproduced on this page and shown full size on Blueprint No. 95; at the same time make the upper deck exactly the same size.

Lay the boiler deck on the engine room, smoke box, and bulkheads, and see if any of them needs sandpapering down to allow the deck to lie flat and conform to the sheer of the hull.

Now cut the holes for the ladders to project through. The central ladder goes up to the interior of the cabin, so needs no apparent opening, but rectangular holes

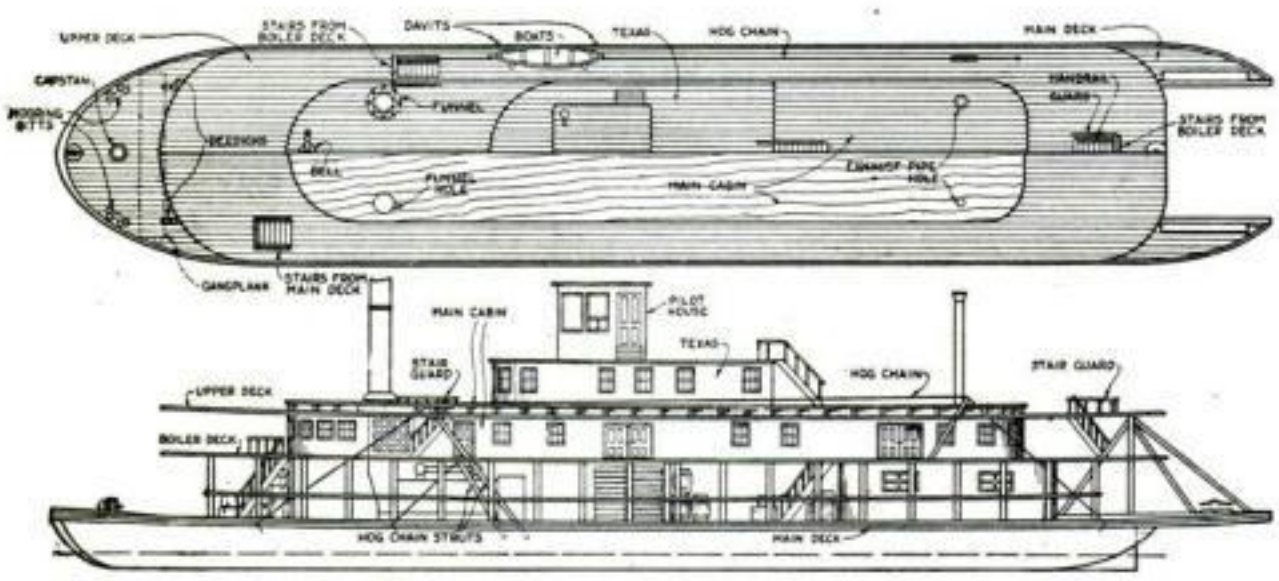
Model of the *Buckeye State* mounted on ripple glass with a scenic background. Other photos will be published later.

½ in. wide by ⅝ in. long are necessary for the forward ones. Mark the deck planks.

Glue the boiler deck down and aid the glue with a few brads. To support its edges, there will have to be a row of posts on either side. For these make some strips of semihardwood, a scant ⅛ by ⅛ in. in cross section. Cut it in lengths to fit exactly between the two decks, from the extreme edge of the boiler deck to close inside the edge molding of the main deck. I made mine a shade long, bound them into a very tight bundle, tapped all the ends level, and then sandpapered the other ends level to the right length.

Glue these in position ¾ in. apart center to center. Bore holes through the deck above and below, and fasten each one, or at least alternate ones, with pin points. The forward ones are set a trifle in on the lower deck.

For drilling fine pilot holes for pins, nails, and other (Continued on page 102)



Top view and side elevation of the model to show the construction of the boiler deck, upper deck, and main cabin. The wheelhouse and a few other fittings shown will be discussed in the next article.

C & L 32

This is one of the most popular blow-torches we have ever made. It is more expensive than the 158 because it is made for much harder use. It is designed for the man who uses a blow-torch in his daily business and demands not only excellent performance but rugged ability to stand rough handling. 32 contains the most advanced patented C & L blow-torch improvements. It also has a red handle with the gold stripe. Sure sign of satisfaction.

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The handles, for instance, are fastened so that even excessive strains won't make the tank leak. The double spring on the pump-valve gives you more positive compression and lasts longer. Even a part like the filler plug is given extra thought, resulting in extra value. We've put a lead washer in there. You know that'll outlive a leather one by years. In the No. 32 torch the control valve is designed to prevent you from carelessly spreading the gas orifice. Yet when you close this valve you automatically clean out the orifice.

Things of that sort have made Clayton & Lamberts the largest selling torches in the world. There's satisfaction and pleasure in working with such a fine, capable tool.

You can buy Clayton & Lambert torches at hardware, electrical and automobile accessory stores. Look for the handle—it's red with a gold stripe. But to be sure—look for the trade-mark too. It pays you to be certain that you're getting a Clayton & Lambert.

C & L 158

This blow-torch is especially made and priced for the man who likes to do odd jobs around the house, or to tinker with mechanical things. It will last a lifetime if it is not abused. The usual retail price is about five dollars. Most hardware, electrical and automobile accessory stores have it—or can get it for you quickly. Look for the red handle with the gold stripe.

CLAYTON & LAMBERT

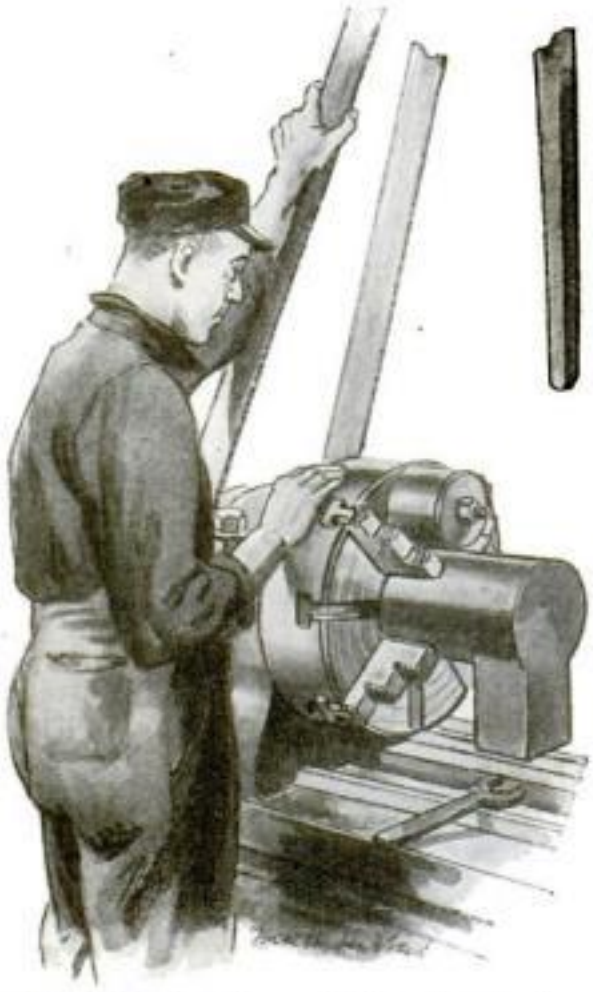
MANUFACTURING COMPANY

Detroit, Mich.

Mounting Your Lathe Work

Hints on Setting Up Awkward, Unbalanced Pieces to Prevent Distortion and Vibration

By HENRY SIMON



This job looks to be well balanced; actually it is better if set up as in Fig. 6, page 109.

EVEN skillful machinists experience difficulty at times in two classes of lathe work—that which requires high accuracy, and large, heavy jobs which may exceed the capacity of the lathe.

In many cases the trouble is due to distortion caused in the spindle and faceplate by strains imposed in clamping and through the weight of the work itself. Sometimes they are recognized for what they are, but more frequently they are not, and for this very reason seem intractable. These disturbances of the spindle assembly are complicated occasionally by misalignments in other parts of the lathe; then it becomes doubly important to know what they are and how to overcome them in order to prevent the "pyramiding" of errors.

When we want to get a piece of fine work just right, we indicate the faceplate to make certain that it runs true. Some of us who have acquired wisdom by experience might decide to take a fine cut off it after it is in position. Yet these precautions are likely to be all in vain, if the work is clamped as at *A* in Fig. 1.

Why? The explanation is seen at *B*. By disposing the clamp *a* as has been done, the faceplate is put under a strain which deforms it all around the area of the bolt, as shown at *b*. This may seem unlikely, but we need only consider that it is easy to exert a pressure of seven or eight hundred pounds by moderately tightening a ½-in. bolt and to imagine such a load concentrated on the unsupported web as graphically indicated at *C*, to realize that the web *must* be deformed under such conditions.

It is true that when the bolts are drawn up lightly no appreciable distortion may result. When the clamping is even all the way around, too, the bulges raised may be symmetrical enough to offset the disaligning effect. But it does not pay to rely on the providential operation of such things when it costs nothing to clamp right and prevent trouble.

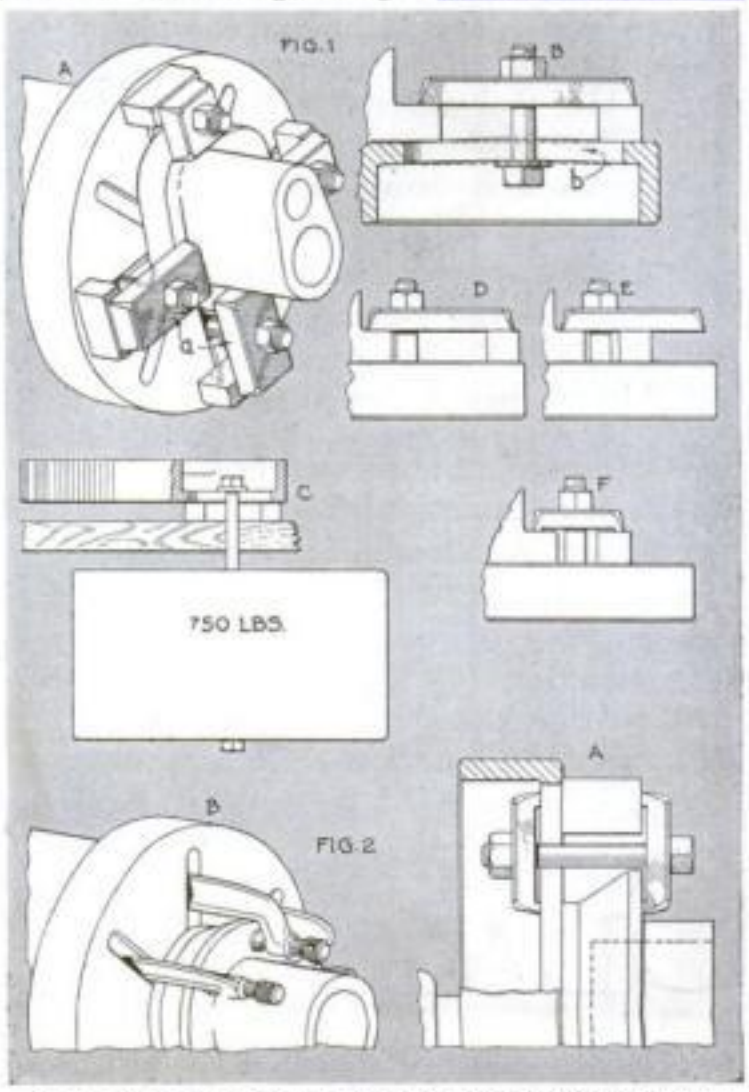
If some clamps on hand have been provided with a slot or a row of holes as suggested in the first article of this series (Dec., 1928, issue), it will be easy to move the bolt up near the work so that practically the entire strain developed will be one of compression of the faceplate and work, as indeed by rights it should be. If the strap is long, it may be used as at *D*, although in heavy clamping it would be better to apply it as at *E*. Ordinarily, of course, the best way will be to use a short strap, as at *F*.

Occasionally the work has overhanging projections which do not allow the clamp bolt to be moved up near the footing. In such cases, distortion of the faceplate is avoided by using a second strap parallel to the top one underneath the web, as in Fig. 2 at *A*. In this manner, the bending strain falls entirely on the two straps, and the faceplate and work are under compression against each other only. Light work of this kind can sometimes also be held by small C-clamps, modified as described in the previous article and shown applied at *B*. Being light, these clamps are not likely to be overtightened, and for this reason alone are ideal for many kinds of delicate work.

PROPER balancing is a most important factor in holding many kinds of unsymmetrical or offcentered work. This is universally recognized by mechanics, and considerable care is sometimes expended in balancing a set-up. The many puzzling and exasperating errors which nevertheless occur, such as taper, oval, and out-of-round bores and turns, are blamed for the most part on other causes, if they are explained at all. How can the fault be with the balancing, when we had just seen with our own eyes that the piece *was* balanced as well as could be?

Nevertheless, the fault *is* with the balancing more often than not. The casting shown in Fig. 3 at *A* and *B* is the same in both cases, and is in both cases balanced by the same weight, in the same manner, and with the weight in the same position. In either case, with the spindle free, it will be absolutely at rest in any position. Yet the set-up shown at *A* will produce a true bore, while set-up *B* will probably vibrate and the bore will be as shown exaggerated at *C*.

The explanation lies in the difference between what is technically called static and dynamic balance. In plainer language, we might say the difference in the balance of a part while it is held still and the balance of the same part while it is rapidly revolving. It would not be far from the truth to say "imaginary" and "real" balance, because when we are balancing a thing (*Continued on page 109*)



Why a faceplate is distorted by the improper use of clamps, and two methods of clamping work with projections.

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No. 530 Steel Tape in handsome black imitation leather case. Exceedingly moderate in price.

No. 94 Combination Square, a wonderful all 'round tool combining marking gage, rule, square, miter, depth gage height gage, level and plumb.

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No. 153 Pistol Grip Hacksaw Frame with Starrett Blade, quick-cutting, long lived.

"Fixin' things or makin' things" isn't work, it's fun —if you have the right tools.

In building a real kit of tools for yourself you'll find the Starrett Catalog a wonderful help. Measuring tools, for example. You won't have to look outside its covers for the right tool or tape whether it's ten-thousandths of an inch or a hundred feet you're interested in. Lasting accuracy and serviceability can be taken for granted with every one of the more than 2500 Starrett Tools.

Let us send you a free copy of the latest Starrett Catalog, No. 24 W. Your tool dealer carries Starretts and will gladly show you the ones you need.

THE L. S. STARRETT CO.

World's Greatest Toolmakers
Manufacturers of Hacksaws Unexcelled
Steel Tapes—Standard for Accuracy
ATHOL, MASS., U. S. A.

Use Starrett Tools

2257

"This Helped Me in My Work"

Expert Machinists Give Shop Hints

IN MY experience of sixteen years as a toolmaker and four years at tool designing, I have never seen a better tool-bit holder than that illustrated in Figs. 1 and 2. I made one for myself and find it saves time to be able to pick up at once the exact tool bit needed instead of having to search for it. Usually the last one that you pick up is the one you need.

The holder has places for twenty-two tool bits, which are held so that one can

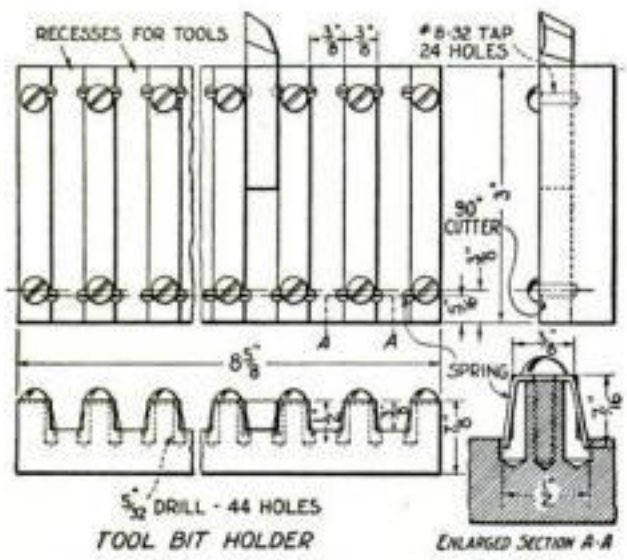


Fig. 2. The holder is a slotted aluminum plate with steel wire springs to retain the tool bits.

see their shapes at a glance. The base plate is aluminum. For a holder of the size shown twenty-four round-head ⅜-in. No. 8—32 screws and the same number of pieces of spring steel wire will be found necessary.—GEORGE A. MCCULLEY.

PENDING the arrival—some weeks off—of a regular broach for use in a broaching machine, it was necessary recently in a large shop to finish a number of blanks which had been roughed out, ready for broaching. Several attempts at hand broaching resulted only in breaking broaches. The foreman then designed a means for supporting both work and broach and broached out a hundred blanks with a single broach, using an ordinary arbor press for his machine. The device used is shown in Fig. 3.

The large knurled sleeve supports the blank (which for clearness in illustrating is shown protruding slightly from the

Fig. 3. Fixture for broaching work on an arbor press, and a spring tool for making graduations.

Fig. 1. It saves time for a machinist to be able to pick up at once the exact tool bits he needs.

Old Bill *Says*—

IF THE boss gives your neighbor the best work, look up a good reason before you begin to criticize him.

To safeguard the end of a piercing punch for tempering, it is advisable to make it with a male center.

If you have to change the cutting edge of a good drill for a brass job, regrind it before you turn it in.

There are only two ways to use a monkey wrench—and one of them is wrong.

High speed steel can now be hardened in lead at 2,500° F.

While waiting for an extra long cut to go through in a lathe or milling machine, it pays to review your machinist handbook.

Sperm oil is excellent for lubricating a high-speed spindle.

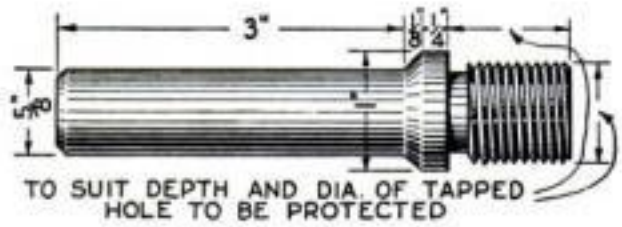
Don't use your lathe for a straightening press. Jamming a crowbar between the work and the cross-feed table will cause you trouble in the end.

If you are not familiar with the sensitive touch of a vernier caliper, have someone else take a reading also, and see if both correspond.

A Tool-Bit Holder and Other Ideas

sleeve) near its lower or left-hand end, while the first member *A* of the group at the right fits in the upper or right end of the main sleeve. A thrust ball bearing comes next, which enables the broach to follow the lead better, since the pressure takes place through *A* and *B* from the ram of the arbor press. The stem of the broach fits in a short hole in the part *A*, and the leading end of the broach is entered in the blank.

When the pressure is applied upon the broach, *A* is well within the main sleeve.



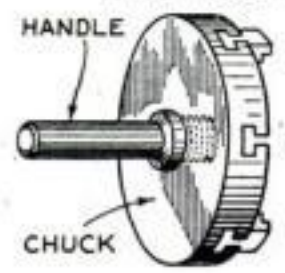


Fig. 4. A plug for protecting the screw thread in the spindle hole of a small lathe chuck. It also makes a convenient handle.

The result is that the broach has every chance to perform its work. The broach which did the work is good for another hundred blanks, in case the proper broach should not arrive in time for the next lot.

In the same illustration is shown a spring graduating tool. Some hardened disks, all finished, were required to be graduated. This seemed to call for an etching process, with lines accurately marked for position as well as for appearance. A rigid tool possibly might have been used, but the operator suggested a spring tool of the construction shown. It worked to perfection.

The cover plate has been removed so that the design will be more readily understood. A small cross slot in the cutter engages a small pin in the right end of the cover plate and allows an adequate amount of movement, at the same time preventing the cutter from escaping from its pocket. Four screws hold the cover plate to the cutter block. The pin at the left of the cover plate is the stop for the spring. In operation, the tool is

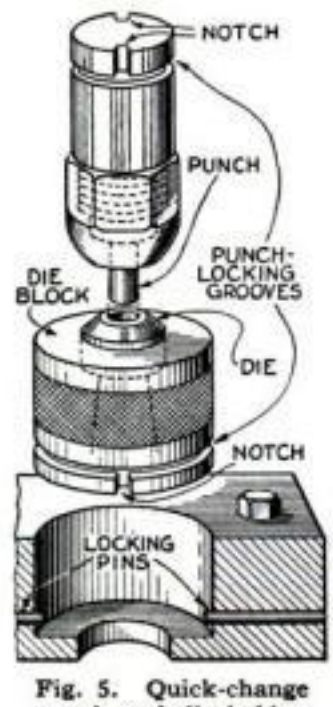
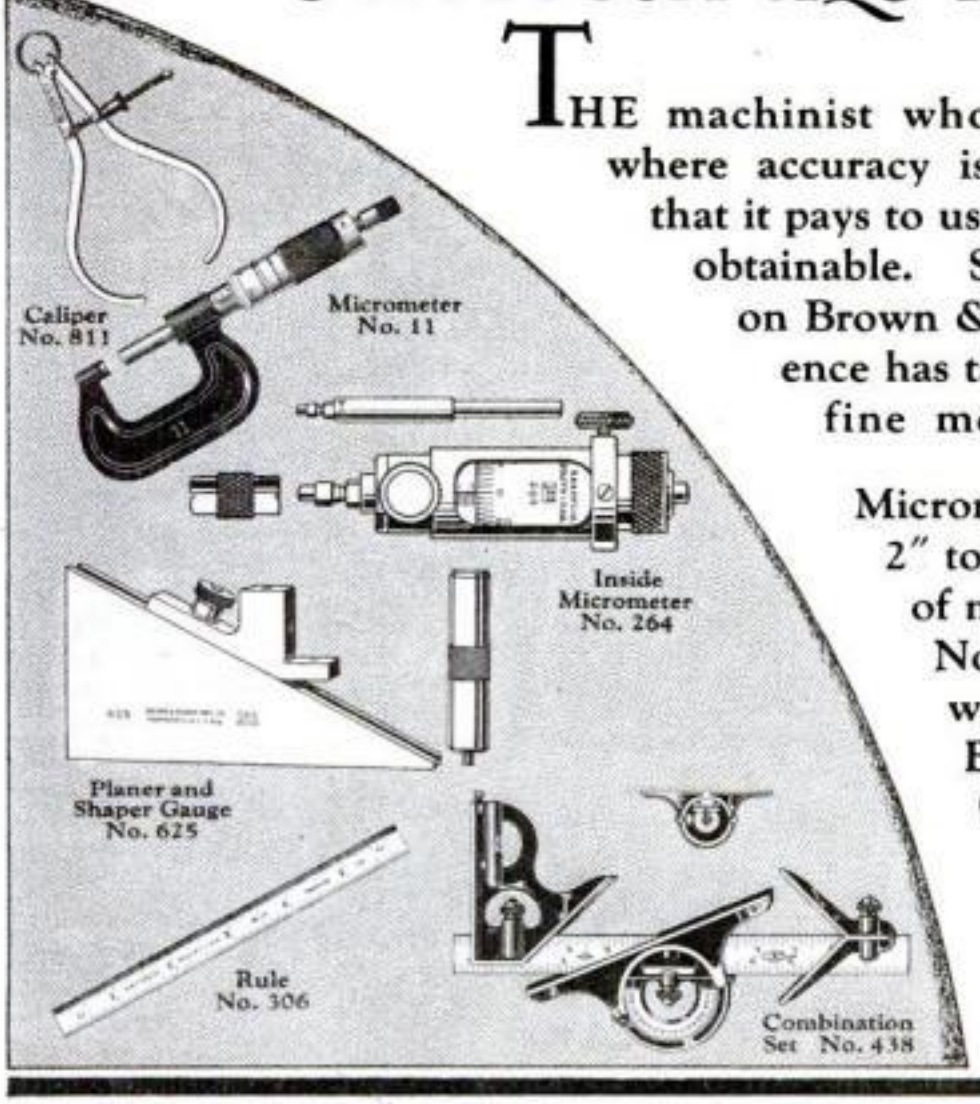


Fig. 5. Quick-change punch and die holder.

(*Continued on page 108*)

His Job Depends On Accurate Work



THE machinist who has spent many years on work where accuracy is essential knows from experience that it pays to use measuring tools of the finest quality obtainable. Skilled workmen everywhere insist on Brown & Sharpe Micrometers because experience has taught them that they can trust these fine measuring tools to avoid mistakes.

Micrometer No. 62 illustrated above (range 2″ to 3″ by thousandths of an inch) is one of more than 2300 tools listed in Catalog No. 30. Get a free copy from your hardware dealer or from us. Dept. P. S., Brown & Sharpe Manufacturing Company, Providence, R. I., U. S. A.

B&S

WORLD'S STANDARD OF ACCURACY

BROWN & SHARPE TOOLS

Among the most thrilling sports of winter are the boyhood battles around a snow fort.

It's Easy to Build an Igloo

And a Big Snow Fort, Too, if You Use a Wooden Form to Help You Press the Blocks into Shape

By J. V. HAZZARD

WITH Commander Byrd and Scout Siple facing strange adventures in the Antarctic, it is safe to assume that a bumper crop of "snow houses" will be built this winter by American boys after what they imagine to be the latest styles of Eskimo architecture.

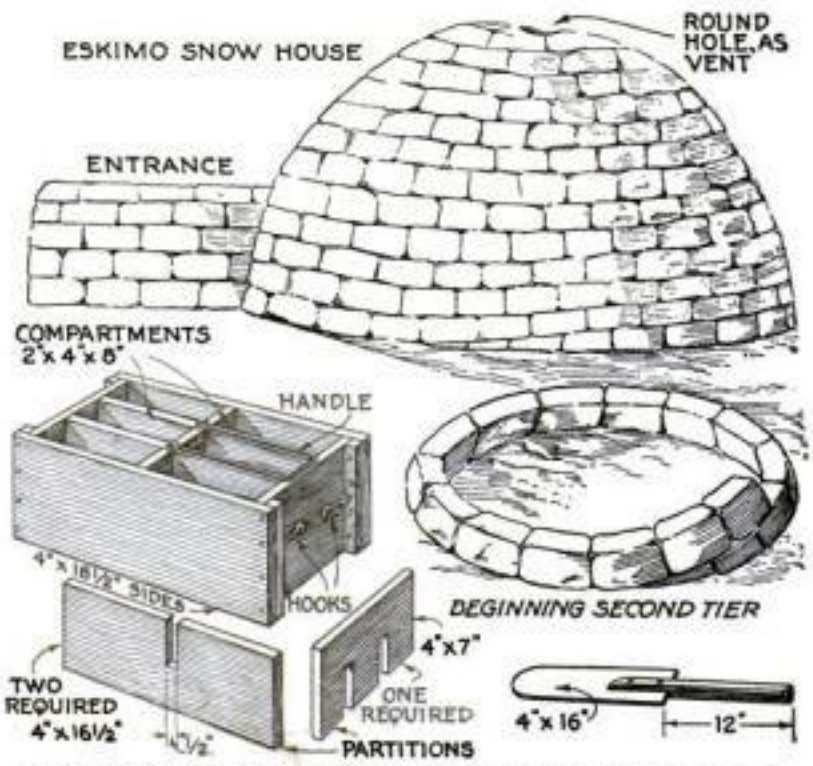
In many parts of the country, however, there is seldom enough snow of the proper consistency for cutting igloo blocks. Suitable blocks can be made, nevertheless, if a form such as illustrated below is knocked together.

The material used is ½-in. white pine, which should be well painted, sandpapered, and varnished before assembly so that the pressed block will not stick to the form. Sidepieces 4 by 18½ in. are prepared and carefully squared, and battens ½ in. square are screwed or nailed across them just inside the ends. The end pieces are squared to 4 by 7 in. and fitted with hooks to hold them in place.

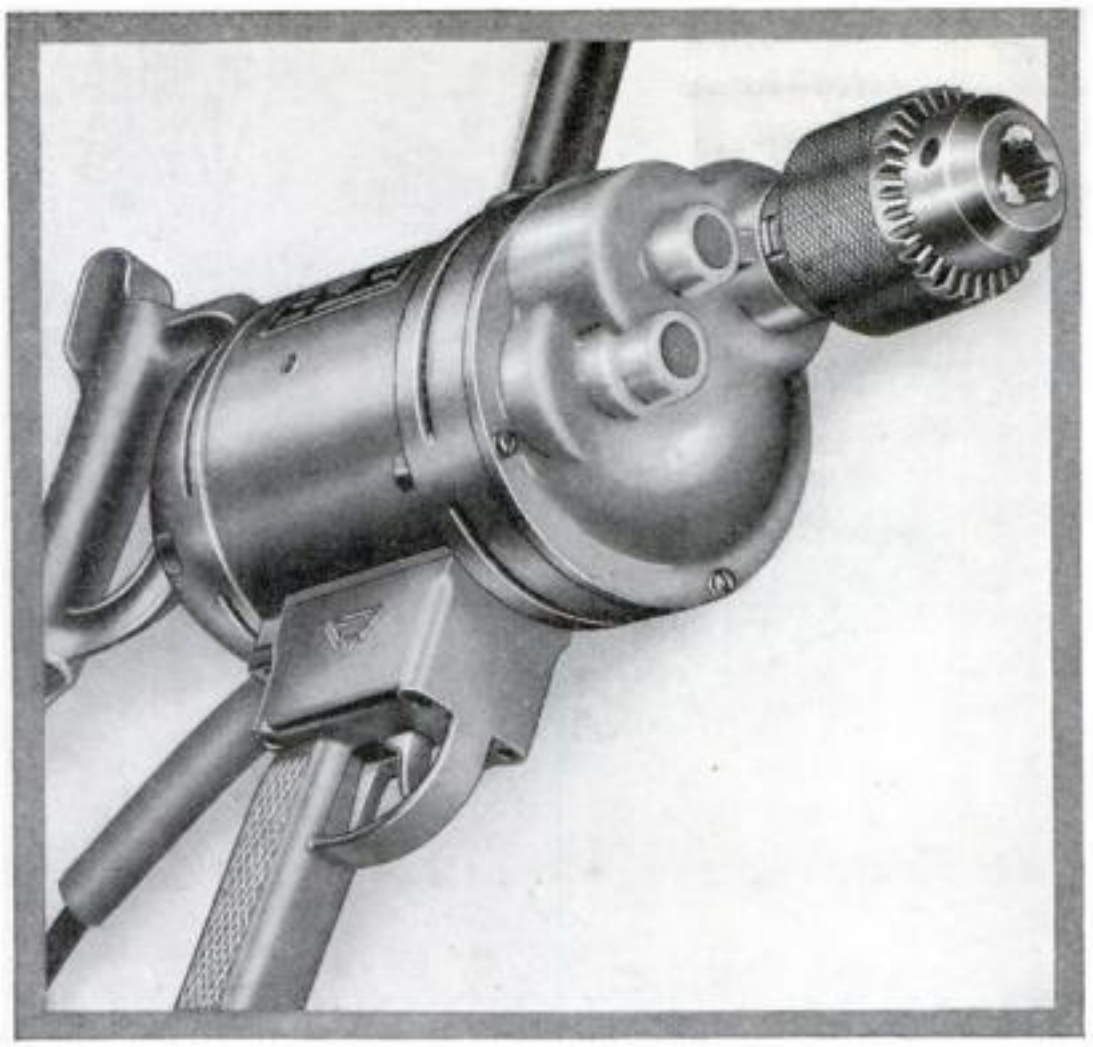
The two longitudinal division pieces (for use when bricks of small size are to be made) are 4 by 16½ in. In the center of each, a slot ½ by 2 in. is cut to take the centerboard, which is 4 by 7 in. and is slotted at 2-in. intervals to interlock with the long pieces.

Before the form is assembled, the slots should be well coated with an ambroid or other type of waterproof cement or glue, and long, slim finishing nails should be driven at suitable intervals to strengthen the joints. The wire handle, while not indispensable, is a convenient addition, and it is little trouble to staple it to the center member of the brick form.

In use, the form (without the partitions) is placed on a board of like material, on a cement surface, such as sidewalk or drive, or on smooth ice, if the structure is to be near the skating pond. Snow is shoveled in until the form is heaping full and then is packed until the block will bear the weight of a hundred-pound boy with just the sign of a track. The form is then unhooked, (*Continued on page 104*)



Wooden form for making either large snow blocks or small bricks; homemade snow knife; method of constructing an igloo.



No. 734
Heavy Duty
Electric Drill

Capacity 3/4" in steel.
Delivers 0.75 H. P.
at the chuck.
Price $78.00

Gain speed·· power increased output

Here's a new power tool that saves workers the long, weary grind . . . . . and brings owners increased production, lowered costs . . . . fast, clean work.

Its builders are tool-makers who use tools themselves . . . . . These men know that *good* tools—made as light as they *can* be without sacrificing power—must make the job easier — on dispositions — on nerves as well as muscles.

So they cut out every ounce of that needless weight that quickens fatigue, kills pep and cuts down production by making more frequent rest periods necessary.

And in place of dead weight, they give you more power, better ventilation, easier control.

No. 734 costs only $78.00. Other sizes from $30.00. A complete electric toolshop with lathe, and 21 different attachments for drilling, turning, polishing, buffing, sanding—only $68.00 . . Saw and saw table $10.00 extra.

Write us to tell you where you can see No. 734 and other Millers Falls Tools. Catalog free.

No. 734 is a joy to use. It's built to precision standards—enjoys the hardest, heaviest sort of drilling, without overheating.

But don't take our word for it. See this tool yourself — *in action.* Put it up against the toughest job you know—*match it against any other drill made.*

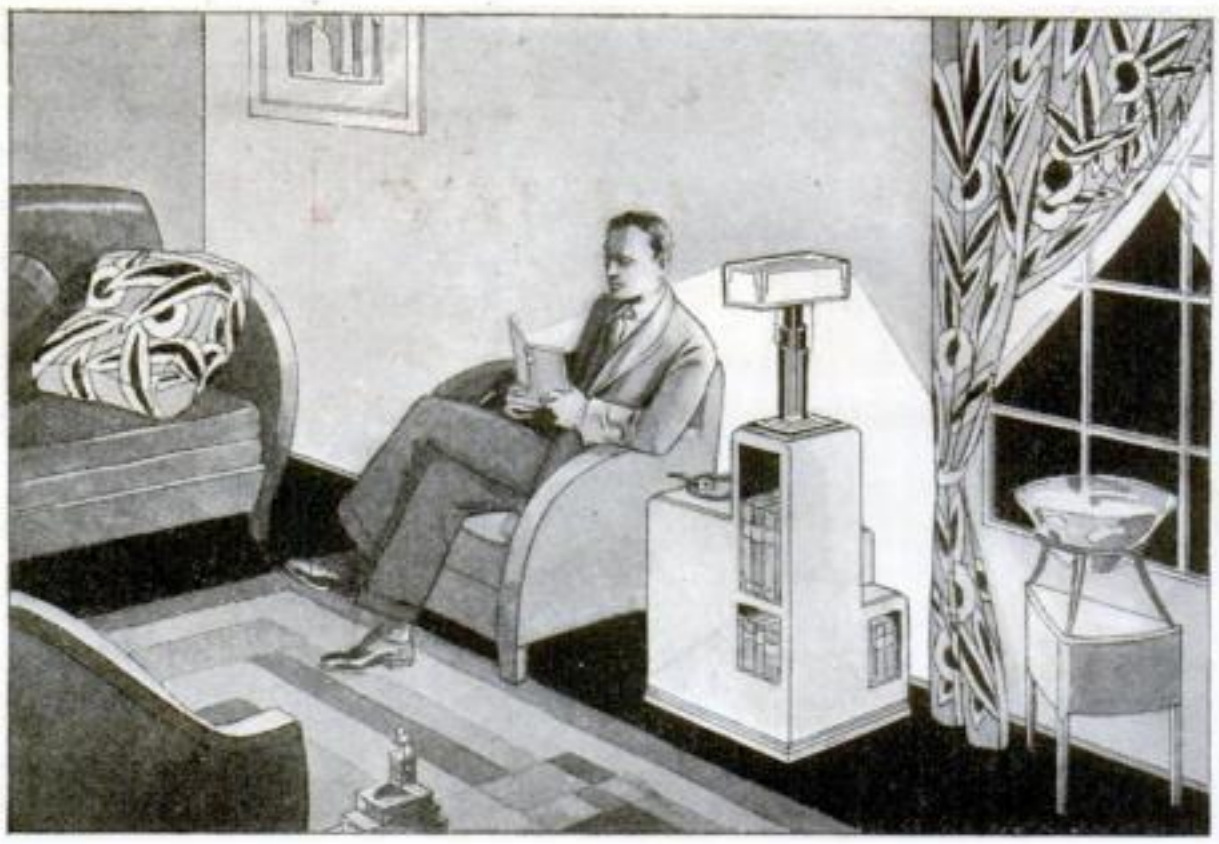
Complete Line from 1/4 inch Standard to 7/8 inch Heavy Duty

MILLERS FALLS Electric Drills

MILLERS FALLS TOOLS SINCE 1868

MILLERS FALLS COMPANY, Millers Falls, Mass.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 12.



What distinguishes this set-back cabinet from ordinary designs is the way it is proportioned.

Cabinet—1929 Model

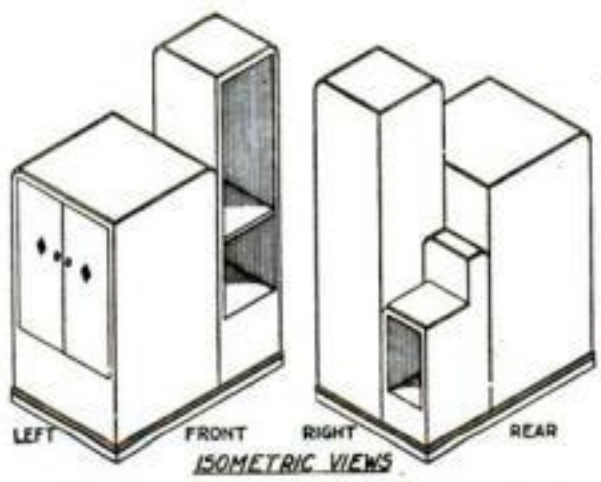
How to Build One of the Simplest Yet Most Characteristic Types of Modern Furniture

By HERMAN HJORTH

THE modernistic cabinet illustrated was designed by W. H. Varnum, Associate Professor of Applied Arts at the University of Wisconsin, according to certain principles formulated by the late Professor Hambidge and described in his book *Dynamic Symmetry*.

Suggestive of modernistic "set-back" architectural design, it is an outstanding example of a style of furniture that commands high prices in the leading department stores. Unlike many of the new pieces, however, it is not too extreme to be used in a room with ordinary furniture, and it is not ungainly in proportions. In fact, it is no higher than a dining room table and it requires a floor space of only 11¼ by 18 in.

The structural features, which may seem rather confusing at first glance, become simple when taken singly. The plan view shows three squares and an oblong placed in a certain relationship to each other. The smallest square and the adjacent oblong are here considered as one unit (*C* in the drawing on page 100). We then have three units, *A*, *B*, and *C*. Taken singly their construction does not present any unusual technical difficulties.



ISOMETRIC VIEWS

Like a modern skyscraper, the piece is interesting from all viewpoints, even the rear.

To build the piece few tools are required. The following will be sufficient: Rip and crosscut saw, rule, try-square, framing square, jack plane, ½-inch chisel, brace, auger bit No. 6, gimlet bit No. 6, screwdriver, hammer, nail set, cabinet scraper, marking gage, miter box, carpenter's clamps.

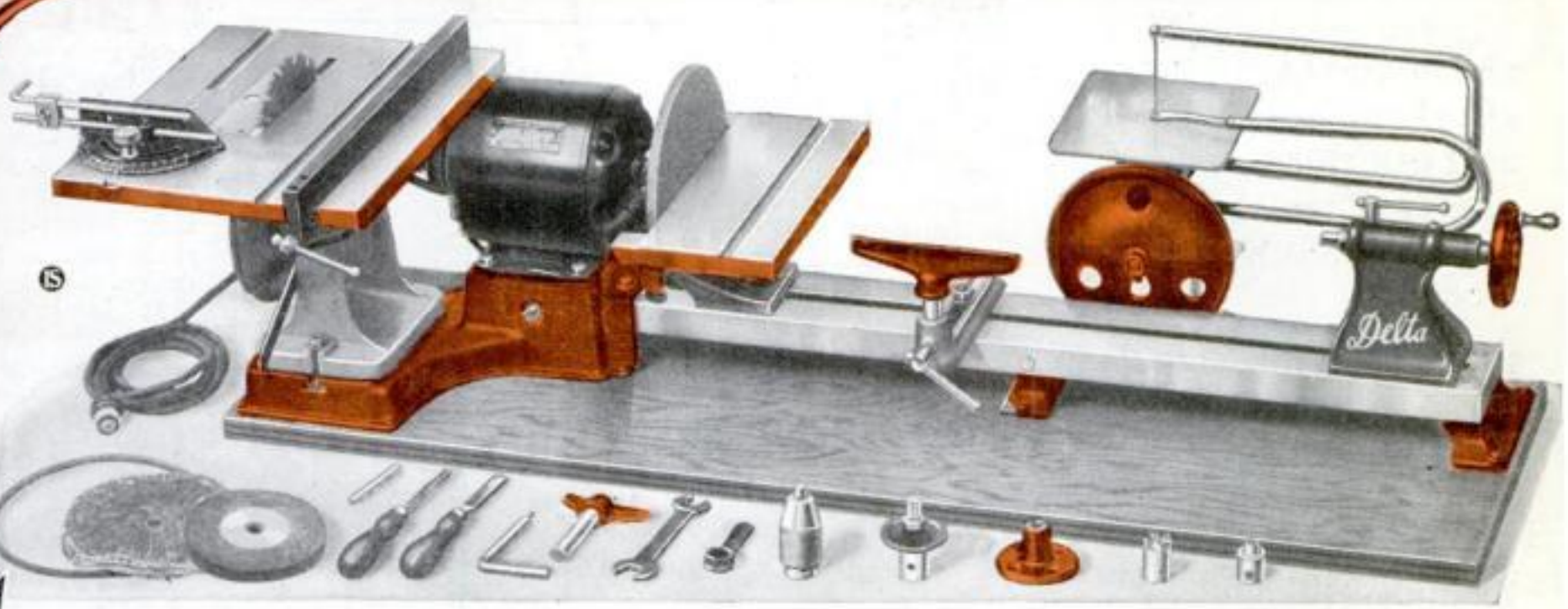
As the material is all ½ in. in thickness, it simplifies matters to use plywood exclusively in the construction. Unit *A* is simply a square box 21½ in. high with two doors in one of its sides. Get out the sides, back, front, shelf, and top of *A* according to the bill of materials. Glue and nail them together. Take particular care to have the corners perfectly square; otherwise the units will not fit when placed together. Smooth all joints, round the upper edges as shown, and glue the ¼ in. thick piece to the top.

The doors also are cut from plywood and carefully fitted and hinged with 1¼ by 1½ in. butt hinges. Two ball friction catches, such as are used on phonographs and radio cabinets, may be used as locking devices, and two knobs also are needed.

Units *B* and *C* are constructed in a similar manner, after which the three are placed

(*Continued on page 100*)

20 New Big Exclusive Features in the 1929 Model "Delta" Electric Handi-Shop



New Features of 1929 Model

found *exclusively* in the "Delta" Handi-Shop, in addition to the many regular exclusive advantages, make this shop one of the finest values in the workshop field. A few of the new improvements are:

- New Delta Miter-Gauge (with many new features).
- New Circular Saw Adjusting Lever.
- New Delta Adjustable Rip Gauge.
- Larger Circular Saw Table.
- 1/3 H. P. Motor.
- Larger Triple Foundation Lathe Bed.
- 1/2 inch capacity Drill Chuck.

For full details, send coupon below.

Make the Things You Have Always Wanted to Make

With this convenient, practical workshop. It's *so easy* and *so quick!* Save money on repair work. Earn money in your spare time. Complete instructions furnished. With each Handi-Shop is included, at no extra cost, complete set of working drawings. Below are a few of the hundreds of articles you can make in a jiffy with a Handi-Shop.

Blue Prints Included

Scores of Exclusive Advantages *in this* Big Husky Home Workshop

The DELTA Handi-Shop is a man-sized, motorized workshop, complete, efficient and PRACTICAL IN DESIGN! Does everything from building full-sized furniture, turning table legs, to finishing delicate detail work. Study the illustrations carefully. Note the **two-shaft motor** that permits **two or three** operations **at one time**—the heavy Triple Foundation U-Shaped Lathe Bed (no rods)—the *practical* arrangement of the Circular Saw that permits the cutting of large lumber without interference—the Improved Tilting Tables on the Circular Saw, Sanding Disc, and Jig Saw, with many exclusive features. Has **automatically oiled** bronze bearings and is **completely assembled** on heavy veneered wood base.

This combination of advantages, plus many more, IS FOUND EXCLUSIVELY in the DELTA HANDI-SHOP! No wonder even last year's Handi-Shop was an outstanding value. **And now, with the many additional exclusive features of the new 1929 model, this shop is in a class by itself — above all comparison — at a new price that is surprisingly low!**

This TWO-SHAFT motor is THE practical motor for the workshop. Permits you to carry on two or three important operations at one time — **without continually dismantling the set-up.**

All DELTA UNITS have 36 in. lathe capacity between centers

This Heavy Triple Foundation U-Shaped Lathe Bed (not rods or rails) is GUARANTEED not to spring or chatter.

10 DAY TRIAL in Your Own Home

without obligation. See how PRACTICAL, how EFFICIENT is this sturdy, full-sized machinery under **actual working conditions.** Study its many exclusive advantages. You will find the Handi-Shop complete with all necessary equipment for **Circular Sawing, Woodturning, Jig Sawing, Sanding, Drilling, Grinding** and **Buffing.**

Easy Terms

Then if you decide to keep the Handi-Shop, you can have your choice of three convenient methods of payment.

Send Coupon

at once for **Free** beautifully illustrated literature giving complete description of the New 1929 Model "Delta" Handi-Shop, with its many exclusive advantages and new features. Also full details of the 10 Day Trial Offer and Convenient Payment Plans.

DELTA SPECIALTY CO.
1661-67 Holton St. Milwaukee, Wis.
Dept. B. 19

WRITE FOR THIS VALUABLE BOOK

crammed full of practical information on how to construct useful and decorative objects. Helpful whether you own workshop or not. Complete directions, illustrations, diagrams. Contains important information on "finishing." If you want this book, send 10c, which merely covers cost of mailing. See coupon below.

DELTA SPECIALTY CO. Dept. B.19
1661-67 Holton St., Milwaukee, Wis.

(Check material desired)

☐ Please send, without obligation, FREE illustrated literature describing new 1929 Model Delta Handi-Shop. Also full details of 10 Day Trial Offer and Easy Payment Plans.

☐ Please send me copy of "How to Make Things with a Workshop." I enclose 10c to cover cost of mailing.

Name.....

Address.....

How to Build a Cabinet—1929 Model

(Continued from page 95)

together as shown in the various views and isometric sketches. Correct any unevenness and screw them together. Smooth all joints with plane and scraper.

The base molding is made of ¼ in. thick plywood. If a small circular saw is available, the molding strip may have a small recess ⅜ in. wide and ⅛ in. deep cut into it; otherwise the groove may be made with a combination plane; or the strip may be left plain. It should be mitered at the corners.

Because the edges of the plywood show to disadvantage in various places on the cabinet, it is best to lacquer or enamel this piece of furniture. The outside surface may be painted in a rather light color, and the edges around the openings outlined in a darker shade of the same color, or in a metallic color like silver or gold. The inside surface should be painted to contrast with outside.

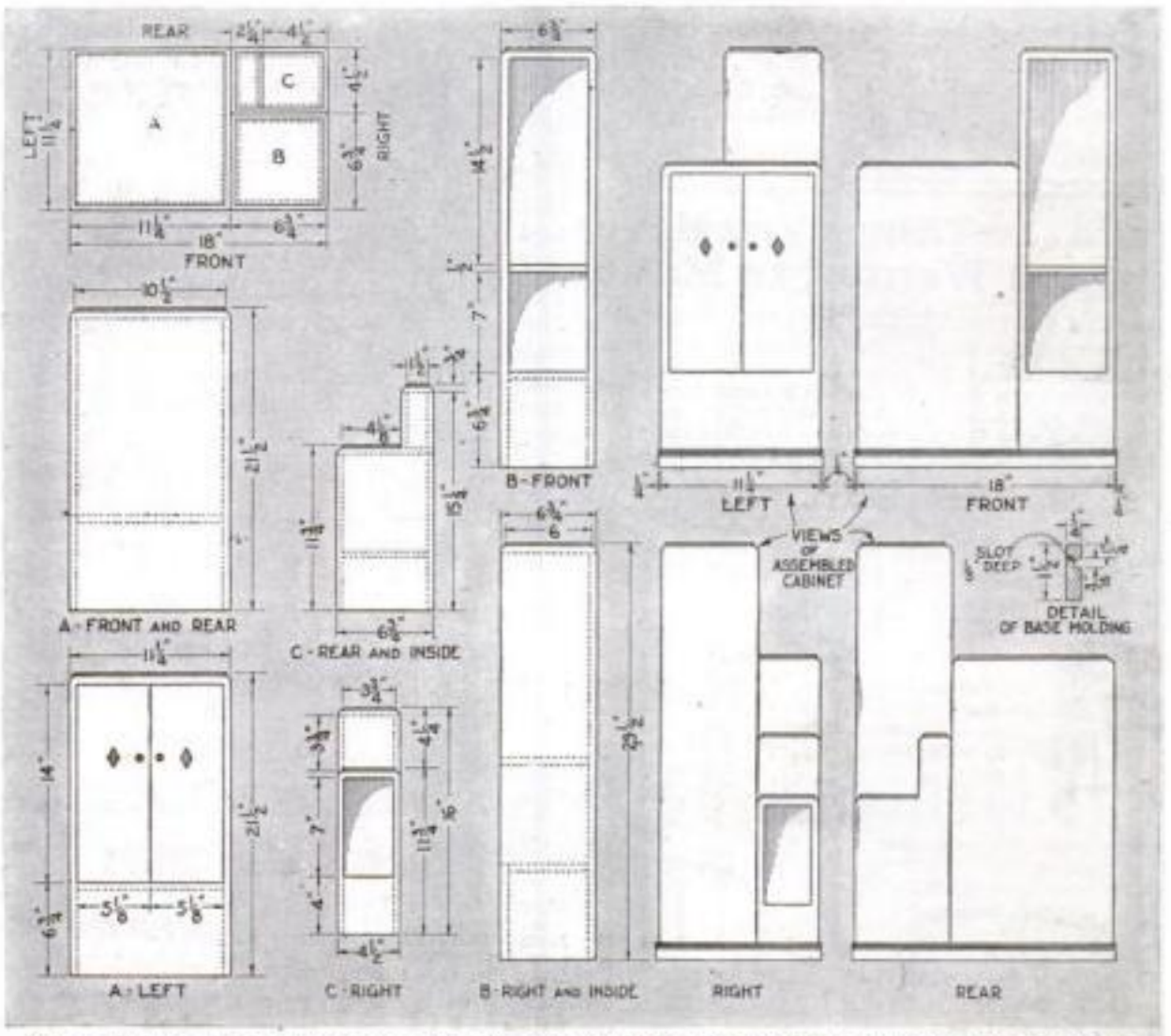
Cutting List

No. Pcs.	T.	W.	L.	Part (For A)
2	½	11¼	20¾	Sides
1	½	10¼	20¾	Back
1	½	10¼	6¾	Front
1	½	10¼	10¼	Shelf
2	½	5⅛	14	Doors
1	½	11¼	11¼	Top
1	¼	10½	10½	Top
				(For B)
2	½	6¾	28¾	Sides
1	½	6¾	28¾	Back
1	½	5¾	6¾	Front
1	½	5¾	6¼	Shelf
1	½	5¾	5¾	Shelf
1	½	6¾	6¾	Top
1	¼	6	6	Top
				(For C)
2	½	6¾	15¼	Sides
1	½	3½	15¼	Back
1	½	3½	4	Front
1	½	3½	3¾	Front
1	½	3½	5¾	Shelf
1	½	4½	6¼	Top
1	¼	3¾	4⅛	Top
1	½	2¼	4½	Top
1	¼	1½	3¾	Top

All dimensions are in inches.

IF YOU have priced any modernistic furniture at high-class furniture or department stores, you know how expensive it is, yet any man or boy who is willing to take a reasonable amount of pains can build fine looking modern pieces suitable for use alongside the best commercial furniture. Because of the very simplicity of the construction of these pieces, it is essential, however, to start with a good design.

It is infinitely harder to design modernistic pieces than it appears to be, and the finest craftsmanship will not save a poor design. For that reason all the modernistic designs in the POPULAR SCIENCE MONTHLY Blueprints Nos. 88, 91, 93, and 100 (see page 105) have been prepared with the advice of Professor Varnum, who is an outstanding authority on problems of industrial design.



The cabinet is made in three separate units marked A, B, and C, which are then assembled as shown in the plan view in the upper left-hand corner and in the views of the completed piece at the right.

FACTORY TO YOU—SAVE 50%—COMPARE WITH COSTLIEST OUTFITS BEFORE YOU BUY

Enjoy a powerful new Miraco AC Electric or Battery set or complete outfit 30 DAYS FREE

3 Year Guarantee

Get Our Send No Money 9th Anniversary Offer!

Values Unsurpassed in the Radio Field

Marvelous new 3-year guaranteed, lighted 1-dial control, All metal Super Shielded Miraco set, removed from cabinet, Front switch, phonograph pick-up connection and all latest features. Built in power section on AC models.

The Latest, Finest and Costliest Construction

$49.88 COMPLETELY ASSEMBLED

8 tube one dial Electric Lighted MIRACO

TRADE MARK REGISTERED

CATHEDRAL TONED, SUPER SELECTIVE, POWERFUL DISTANCE GETTERS

Celebrating its 9th successful year, America's big, old, reliable Radio Corporation springs a genuine sensation in high-grade sets. With its latest, Super-powered, 1-dial Miracos—the All Electric wholly self-contained, hum-free, AC-8 and AC-9, using AC tubes or the new 8-tube models for batteries or Eliminators—you are guaranteed values and savings unsurpassed in the fine set field.

Compare a Miraco with highest-priced radios, for 30 days in your home. Surprise and entertain your friends—get *their* opinions. Unless 100% delighted, *don't buy it!* Return everything—*the complete outfit*—at our expense. Your decision is final—absolutely!

Only exceptionally fine radios, of the very latest approved type, at rock-bottom prices, could possibly back up so liberally unconditional a guarantee. Send coupon now for *Amazing Special Factory Offer!*

Don't Confuse with Cheap Radios

With its rich, clear Cathedral tone, hum-free operation, tremendous "kick" on distant stations and razor-edge selectivity—with its costly sturdy construction, latest features, including phonograph pick-up connection, ease of tuning, beauty, and economy — a Miraco will make you the envy of many whose radios cost 2 to 3 times as much!

BIG DISCOUNTS
Exclusive Territory to User-Agents on
BATTERY OR AC ELECTRIC OUTFITS

Many thousands of Miracos—bought after 30 day home comparisons—are cutting through locals and getting coast to coast with the tone and power of costly sets, their delighted users report. Miracos are laboratory-built with finest parts, and embody 9 years' actual experience in constructing fine sets. Approved by Radio's highest authorities.

Deal Direct with Big Factory

Everything reaches you splendidly packed and rigidly tested to insure your instant enthusiasm. Enjoy the outfit 30 days—then decide. Liberal 3-year guarantee on each set. Play safe, save lots of money, and insure satisfaction by dealing direct with Radio's old, reliable builders of fine sets—9th successful year.

AC-8—$71.50

Unbeatable value in a 3-year guaranteed Super Shielded Metal Chassis.

Also New, More Powerful Battery Sets

The newest and latest in battery operated sets, designed with same advanced features used in electric sets! Same wide choice of cabinets. Highest quality, amazingly low priced!

NEW LOW FACTORY PRICES

SAVE 50%

Wide Selection of Beautiful Cabinets AC or Battery Sets

30 DAYS HOME TRIAL

Richly designed, genuine walnut console of finest type. Electro-dynamic or magnetic power cone, or long air column speaker. Marvelous value.

A popular walnut Hi-Boy Console, with drop-leaf desk. Beautiful two-tone finish. Rare bargain!

Beautifully graceful Spinet console, genuine two-tone walnut. Choice of speakers. Also comes in Electric Phonograph-Radio Combination.

A new-type arm-chair console. Genuine walnut. Very pretty. Low priced. Electro-Dynamic or Magnetic-Power Speakers.

At right, a Lo-Boy console, walnut finish, that costs little. A gem!

Above, popular inexpensive combination. Set on Table Speaker (sold separately).

Metal or wood compact style cabinets. Wood cabinets in walnut or new shaded silver-chrome finishes. Cathedral Electro-Dynamic or Magnetic-Power Speaker to match!

Miraco Outperforms 'em All In Chicago

On the Miraco Unitune, to start with, will say: I got to date 61 stations outside of Chicago, from the Pacific Ocean to the Atlantic Ocean, and from Anchorage, Alaska, to the Gulf of Mexico, and I tried the set with 3 different antennas. That is an outside aerial 152 feet, an inside aerial 20 feet, and light socket. I want to say that your set does outperform the other sets I have. I put it up against a World Record Super 9 and beat that one. Then I put it up against a (names expensive make), and beat that one. Next I put it up against a Neutrodyne and beat that one. HARRY KOPP, 6555 South Peoria Street, Chicago, Illinois.

MIDWEST RADIO CORPORATION, 408RJ Miraco Building, Cincinnati, Ohio

BEAUTIFULLY ILLUSTRATED CATALOG, AMAZING SPECIAL FACTORY OFFER, TESTIMONY OF NEARBY USERS—All the proof you want—of our honesty, fairness, size, financial integrity, radio experience and the performance of our sets—including Amazing Factory Offer—sent with catalog.

Free!

MIDWEST RADIO CORPORATION
Pioneer Builders of Sets—9th Successful Year
408RJ Miraco Bldg., Cincinnati, Ohio

THIS COUPON IS NOT AN ORDER

WITHOUT OBLIGATION, send free catalog, Amazing Special Factory Offer, testimony of nearby users, etc. ☐ User ☐ Agent ☐ Dealer

☐ **Check here if interested in an EXCLUSIVE TERRITORY PROPOSITION**

NAME ADDRESS

How to Build a River Packet

(*Continued from page 90*)

purposes, the best thing is a fine twist drill, of which a great range of sizes may be bought at any large hardware store or jeweler's supply house. These drills are set in a drill vise handle. Substitute drills can be made of the smallest steel crochet hooks (No. 14) by grinding off the hooks and bringing the end to a V-point.

When these stanchions are up, nicely vertical and even, put the handrail on $\frac{3}{8}$ in. above the deck. A piece of hardwood $\frac{1}{16}$ by $\frac{1}{8}$ in., half notched to take the stanchions, is the best. Clip the strip in position and mark the location

Main cabin and texas. To show the cabin more clearly, the upper deck has not been placed.

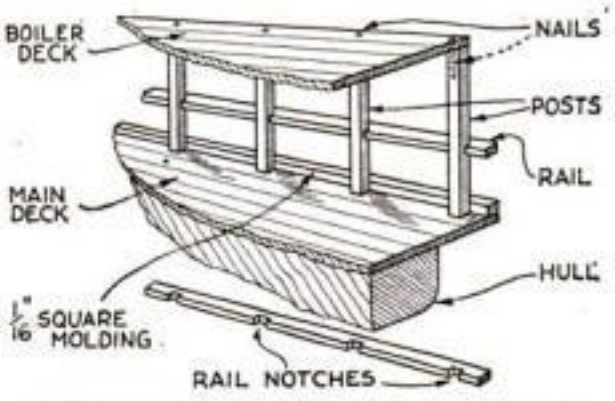
of the notches from the stanchions themselves, not by measurement. Glue it in position and drive an occasional pin point.

The *Buckeye State* had an elaborate system of hog chains, which, on the cantilever principle, prevented the vessel from hogging, or drooping, at the ends. The parts that can be seen and should be embodied in the model are shown on page 90 and on the blueprints.

At this time we shall put in only the struts for the boiler chains on both sides of the boiler, the chains from them, and the piece of Main Chain No. 1 that shows. The struts are $\frac{3}{32}$ in. square wood; and the chain (really iron bars), No. 22 wire.

To place them, bore $\frac{1}{8}$-in. holes through the boiler deck and smaller holes for the wires. As there is nothing to disturb them, they will not need to be secured in any other way. Cut the upper ends off flush with the deck. They might be white, but I made all my hog chains black for emphasis.

The next requirement is the main cabin house. It may be a solid block or be built up hollow. I made the main cabin solid; the texas, which is the cabin above, of $\frac{1}{16}$-in. three-ply wood; and the pilot house of two layers of



How the posts are set up between main and boiler deck, and how the handrail is notched.

Bristol board. The three-ply method is a lot of trouble and not so satisfactory when done, so I will describe only the other two methods.

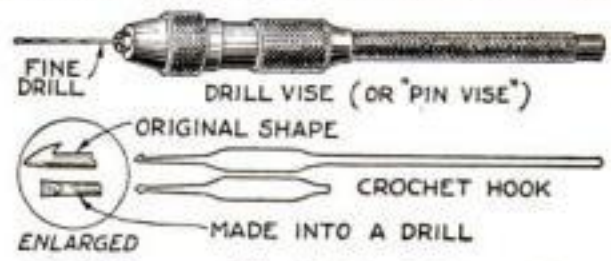
The difference in appearance between the solid and the hollow method is that with the latter the windows can be of transparent celluloid (washed photo film) or open and the doors can open, revealing an interior, if desired. However, a solid block is substantial to build with, so I suggest making the main cabin in one piece and building up the texas and pilot houses.

The solid cabin house, then, is a block of wood $\frac{11}{16}$ by $2\frac{1}{4}$ by $11\frac{3}{4}$ in. The front end is rounded to about 1 in. back, and the after end is square, with only the corners rounded. It will be planed both above and below to conform to the sheer.

It is enameled white and the doors and windows are painted on. The gratings under the funnels are to ventilate that part; they can be thin gilt strips on a blue-black background. The windows should be painted a light blue, streaked across with a little white, and have white crossbars; the doors may be mahogany color with white panels; and the windows also may be outlined with mahogany. Small pin heads will serve for door handles.

It will be noted that the upper deck is placed $\frac{1}{8}$ in. below the top of this house, so that a row of skylight windows shows above the deck everywhere except over the ventilators.

The other method of making a deck house is to cut a piece of wood of similar shape but only about $\frac{1}{8}$ in. thick. It should be less in size all around by the thickness of two sheets of thin



Small holes are drilled by hand either with a twist drill or a modified steel crochet hook.

cardboard. Around this fit two pieces of cardboard of the right height (not forgetting the sheer) to give a double-thick wall. On the inner piece leave tabs extending to be bent in so that the roof may be glued to them. Mark off the windows and doors and glue the pieces together along the bottom only, while holding them in position around the base. Have the joints in different positions, but do not glue the ends together.

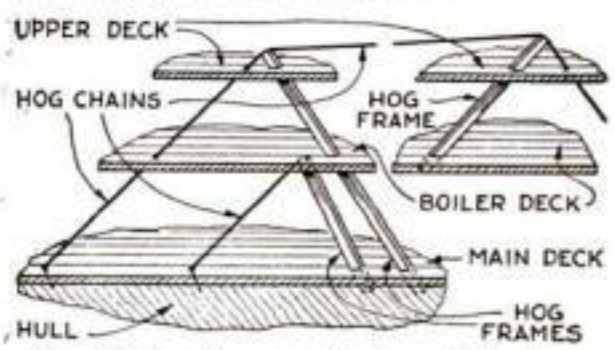
When the glue has set, cut out the windows through both pieces, but cut out the panels of the doors in the outer piece only. Spread glue on the inside of both pieces of cardboard. Put the thinnest obtainable gelatin or celluloid between them where the windows are and fasten them together.

Paint in the sash bars, glue the sides to the base piece, and glue the overlapping ends together, making sure that the walls are upright. Erect a few cross bulkheads inside to stiffen the whole. Give the cabin at least one coat of white enamel inside and out, with mahogany trim as desired.

Lay the cabin upside down on the upper deck and mark its outline. Cut the center of the deck away so that it will fit tightly over the house in a position $\frac{1}{8}$ in. down from the upper surface. Glue the house firmly in place.

Mark the deck planks and give the upper and boiler decks a thin coat of varnish, but do not yet put the upper deck in position.

Next month we will lay the upper deck and proceed with the superstructure.



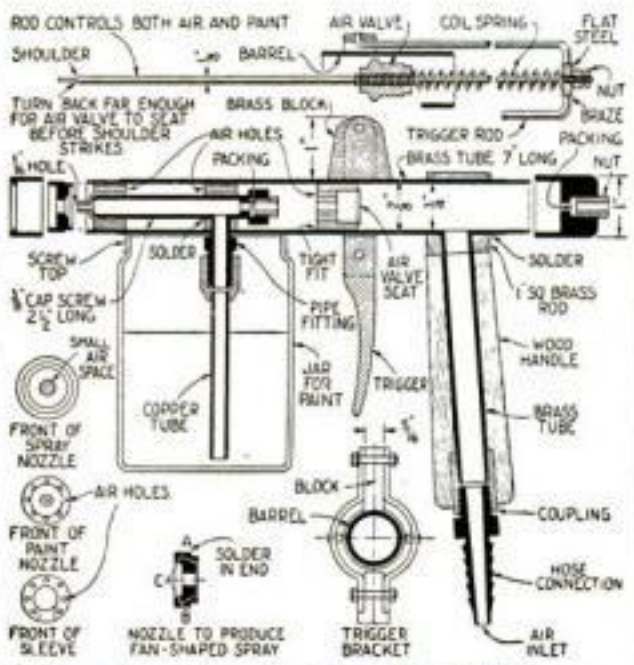
How the hog frames or struts and the chains are set up. Their location is shown on page 90.

Makes Paint Sprayer at Small Cost

Homemade sprayer controlled by trigger.

HAVING many small paint jobs to do about the shop and also desiring to repaint my old car, I looked about for a good paint sprayer. The cheap ones did not come up to my idea of good mechanical design, and the more expensive did not fit my purse. So, having a lathe and shop at my disposal and an air supply which I could use, I made the sprayer illustrated.

I desired a spray with a trigger for controlling both the air and the flow of paint, as the cheaper sprays, which give no control over the paint flow, are continually clogging up with paint dried on the nozzle. As shown, I incorporated all



How the paint sprayer is made. The trigger controls the flow of both air and paint.

working parts in the barrel of the gun, which is a 7-in. length of brass tubing, ¾ in. in inside and ⅞ in. in outside diameter. As these diameters are only approximate, all fits have to be made exact when the parts are turned. It will be seen that the point on the valve rod must be turned back far enough for the valve to seat before the shoulder strikes.

The spray is well balanced, easy to handle, and does a first-class job. As many different kinds of nozzles may be made for it as desired. For all ordinary purposes, however, a properly controlled, plain round spray is sufficient. The pressure should not be more than 40 or 50 pounds.

If a separate nozzle is desired to produce a fan-shaped spray, it can be turned and drilled as shown, but care must be taken that the air columns marked *A* and *B* converge exactly to the point *C*. Solder their outside ends.—J. D. George.

There is never an excuse for breaking the ends of a board with a block plane. Every stroke of the plane across the end wood should be stopped before it reaches the farther edge.

Setting Up a Bench Saw Table

(Continued from page 88)

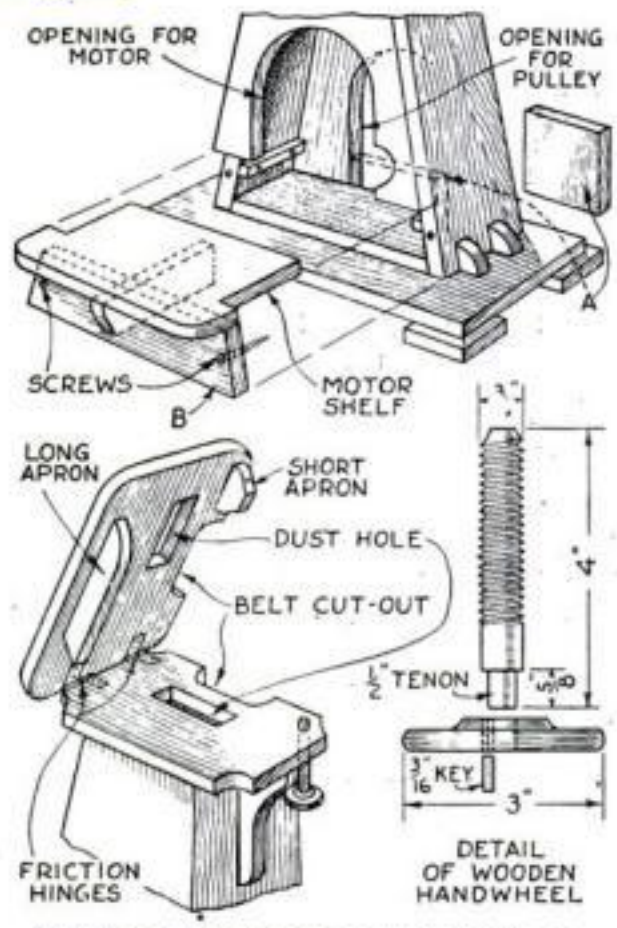
so that when dropped flat the table will be level both ways. Ordinary butt hinges might be used if carefully fitted, but they will not as effectively overcome the slight vibration resulting from the high-speed operation of the saw.

If the table has the tilting feature, care should be taken not to get the platform so wide as to interfere with the stock when tilted to a full 45 degrees. The dimensions given are arbitrary and should be adapted to the saw table used.

The action of the handwheel is to raise and lower the saw and the upper half of the platform to which it is bolted, thus tightening or slackening the belt at will. In this case the wheel and screw are made of wood, threaded in a ¾-in. screw box. The spindle carrying the thread was turned from a piece of maple with a ½ by ⅝ in. round dowel or tenon left on the end as shown. The wheel was turned and drilled separately, driven on the tenon in glue, and keyed as shown with a ⅜-in. dowel rod. A similar thread was tapped through the fixed section of the platform, after a piece of ⅜-in. maple had been let into the platform to receive the tapped hole. This thread will last indefinitely if greased occasionally.

If the worker does not have a screw box and does not care to invest the very nominal sum required for a good one, it is possible to accomplish the same action with an iron handwheel and nut, the nut being let into the wood and the end of the threaded part bearing against a piece of metal fastened to the lower side of the platform.

With the exception of pine and the other very soft woods, which will not do at all, the selection among the hard and near-hard woods is a matter of choice; but, of all that might be used, sound gumwood is the author's choice.



How the motor support or shelf is built as a removable unit; the belt tightening device.

It presents a better than average surface to the glue, holds the screws well, and, when thoroughly sandpapered and given two coats of brushing lacquer over a suitable primer, it presents the nearest appearance to metal that may be had. Two 1 by 12 in. by 12 ft. gum boards, or an equivalent amount, will be ample.

It's Easy to Build an Igloo

(Continued from page 96)

Typical snowball shields, which can be made from barrel heads or staves and painted.

the block shoved to one side, and the process repeated until a sufficient number of blocks are at hand. With these blocks it is surprisingly easy to build a true Eskimo igloo.

First draw a circle on the snow with cord and stick. Place a line of large blocks about the circle, fitting the ends closely together.

You will need a knife to trim the ends of the blocks so that they may fit without "chinking." A large butcher knife will do, or a slat of hardwood may be whittled to a sharp edge; but by far the best instrument is made from a piece of cold-rolled steel ⅛ by 4 by 16 in. as shown on page 96.

Before starting the second row of blocks, one of the first row should be cut through to the bottom as indicated in a sketch on page 96 and the adjoining blocks whittled away until they form a slanting base up which the second-row blocks can climb evenly. The bottoms of these are shaved slightly to give them a uniform inward tilt, and their ends must be beveled to fit one another closely. Each block rests against the end of its neighbor and is prevented from falling inward because its outer face is larger than the inner.

From here on construction proceeds merrily. The tiers of blocks go spirally round and round the igloo and the bottoms are trimmed more and more as the rounded top is reached, where a small round hole is left as a vent.

The igloo is completed by cutting a door at the desired point and constructing, if desired, the usual low arched passageway. Cover the vent and place a lighted oil heater inside for an hour or two, or until the roof of the igloo shows signs of melting; then remove the stove and open the vent to allow the escape of the heat. The walls and roof will soon freeze, and the coating of ice will prevent snow from falling.

The large blocks are also excellent material for the facing of snow forts. Small bricks, made by using the partitions within the main form, are placed on top of the ramparts.

And—speaking of the assault—excellent shields can be made from barrel heads or staves as shown on this page.

Blueprints for Your Home Workshop

OUR blueprints can be obtained for 25 cents a sheet. In some cases there are two or three sheets to one subject. The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine in which the project was described in detail, it can be had for 25 cents additional so long as copies are available. Other subjects besides those below are to be had; send a stamped envelope for the complete list.

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Furniture Polishing Secrets

How to Restore the Glow to Dull Looking Antiques—Removing Spots and Rings

By R. C. STANLEY, *Expert Furniture Restorer*

AFTER a piece of old furniture has been oiled and waxed, as suggested in the article on refinishing antiques in the November issue, the grain of the wood, especially in dark wood, may appear white. This is nothing to be discouraged over; it proves that the grain has been well filled with the wax, as should be the case.

"White grain" is easily eliminated by rubbing the piece down with either raw or boiled linseed oil or with a good furniture polish. Polishing does not remove the wax from the grain.

There are also times when wood that has had undue exposure to the weather will look "sick" and lifeless after it is oiled. The life, or deep luster, which the wood should have, may be restored by a modification of the French polish.

Fig. 1. Applying clear varnish to a rubber made of cloth for use in a modified French polishing process.

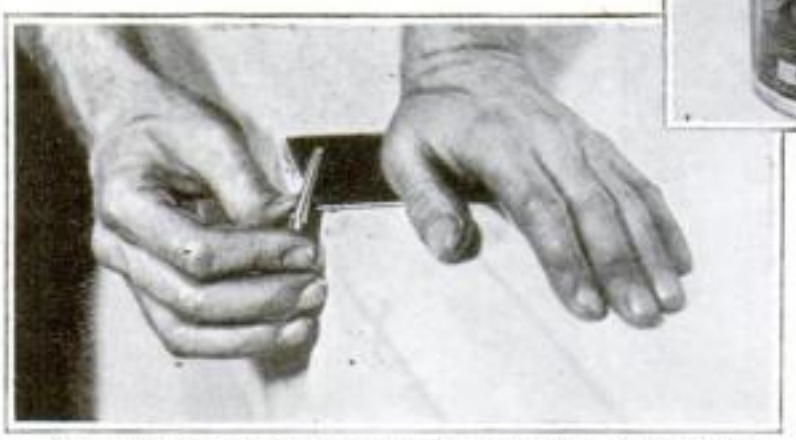


Fig. 2. How a cabinet scraper is sharpened by slightly turning over the edge with a burnisher or any nail set.

To apply this polish, make a rubber (large enough not to cramp the hand) from cotton cloth and apply a good grade of clear varnish to the rubber with a small brush or swab as shown in Fig. 1. With the finger tips or a very small brush or swab, add a few drops of raw linseed oil to the center of the varnish already applied. Then rub the wood with a circular or across-the-grain stroke. Repeat the application of varnish and oil as often as necessary and rub well until a good coat of varnish has been applied. It will be noted that the fine color is returning to the wood because, with the aid of the oil, the varnish is being rubbed into the wood instead of onto it.

When the color has been restored, time must be allowed for the varnish to dry, and the presence of the oil will probably prolong the process. When dry, the piece will appear cloudy because of the oil. This cloudiness may be removed by rubbing with wood or denatured alcohol.

If a dull rubbed natural wood finish is desired, the piece should be sandpapered with No. 0 or ½ sandpaper, then rubbed down well with No. 0 steel wool (this will remove some of the varnish but not the restored color), and waxed and rubbed as told in the November issue.

If a highly polished surface is desired, the polish is carried to a finish by sanding lightly with No. 00 sandpaper the first coat of oil and varnish, after the alcohol rub; then adding two or more coats in the same manner, treating all coats alike except the last, which is given only the alcohol treatment and a thorough rubbing with a good furniture polish or polishing oil.

The French polish does not change the color of the wood; it merely brings out the natural color and shows it to best advantage. In many instances, however, it is desired to make a walnut or mahogany piece darker (*Continued on page 113*)

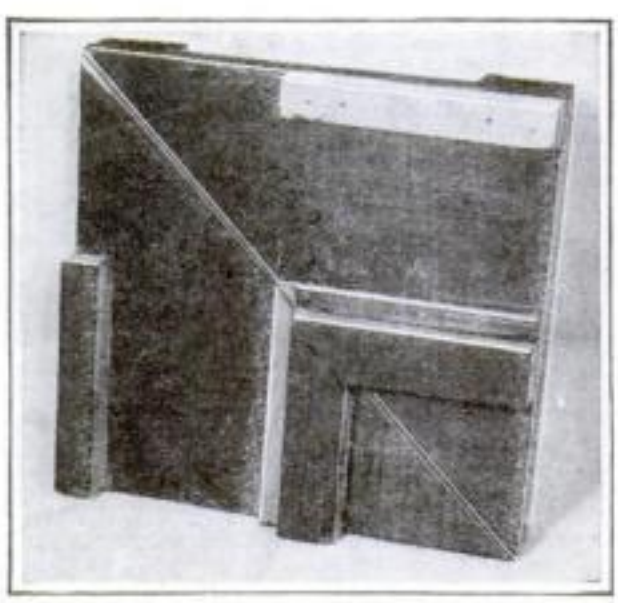


Fig. 3. A homemade wooden clamp for joining frames. It is shown in use on page 113.

Oil Burner Improved with Baffle Plates

By GEORGE FULLER

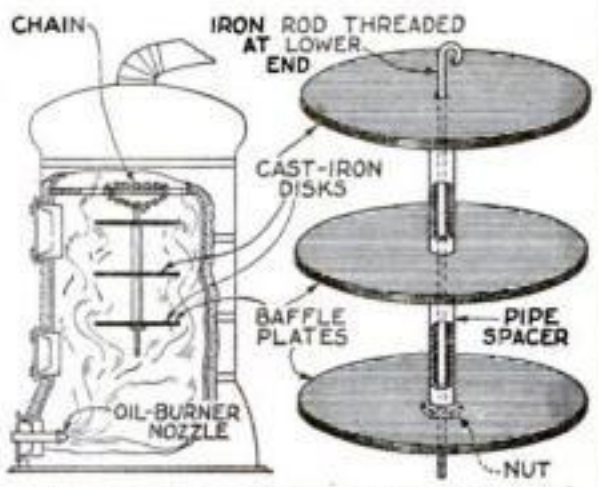


Diagram showing the baffle plates in place and a larger view of the baffles themselves.

A YEAR or more ago I had one of the best oil burners installed in my home. After some use I realized that the boiler, like most home boilers, could not absorb all the heat which the oil gave off in burning. A large part of the hot gases went rapidly up the stack.

The most promising remedy seemed to be some system of baffle plates. Naturally, the size of the baffle plates I could use was determined by the width of the furnace door. The heat was too much for thin steel, so I tried ⅜-in. pressed asbestos. While the disks in the upper part of the furnace stood up, those nearest the flames would crack after a short time. Finally I used thin cast iron, which appears to be satisfactory.

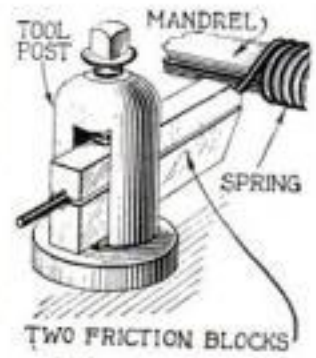
I threaded a strong chain through the holes in the upper section of my furnace and hooked it together at the top, making a loop. Then I made a ½-in. rod, threaded at one end and with a hook at the other end to engage the chain loop at the top of the furnace. Three disks about 15 in. in diameter were placed on the rod in the furnace and held apart by pieces of pipe. The disks and spacers were held in place by a nut. Two disks, I discovered, gave almost as good results as three. It is best to keep the bottom disk at least 6 in. away from the flame level.

The baffle plates throw the hottest gases to the sides of the furnace, where the heat is absorbed by the water. In addition, I believe the gases swirl around more when they reach the upper sections.

This apparatus has been thoroughly tested and has been commended highly by one of the oil-burner manufacturers; in fact, the company has suggested the installation of similar apparatus with necessary variations in at least fifty homes from New York to Florida.

With the same average temperature outside, I found that in the morning the steam showed at any particular radiator in from twenty to twenty-five percent less time when the disks were used than when they were not used. As my furnace is new and fairly efficient, the apparatus might save more in some less modern plants. The annual saving in oil represents many times the small cost of installation.

A Spring Winding Tool

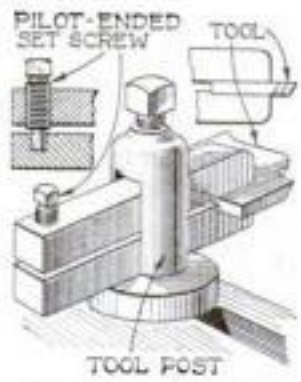


Tool post guide for winding spring wire.

THE spring winding tool illustrated can be quickly and cheaply made and will give complete satisfaction. It consists of two pieces of machine or tool steel of about the width of standard lathe tools and of a height to suit the tool post. The upper and lower sections have a V groove, from 1/16 to 1/8 in. deep, planed the entire length. Any tension desired on the wire is obtained by tightening the tool post screw.—H.L.W.

Holding Flat Form Tools

FLAT forming tools of varying thicknesses may be held in the tool holder illustrated with equal security. It is simply two square pieces of steel with a pilot-ended set screw in one of them, and a shoulder planed for the tool in the other.



How the tool holder is made and used.

It would usually be used on the larger lathes for forming heavy work, and, of course, should be made as rugged as the tool post will allow.—G. A. L.

"This Helped in My Work"

(Continued from page 94)

held on the miller arbor and gripped between a pair of cutters, a method familiar to toolmakers.—O. S. MARSHALL.

TO PROTECT the spindle hole of small, or even large, lathe chucks, the handle shown in Fig. 4 will be found efficient. The writer has three in use. The handles, after being screwed into the chuck, can be placed through holes bored in a shelf, thereby holding each chuck in place.—FRANK N. COAKLEY.

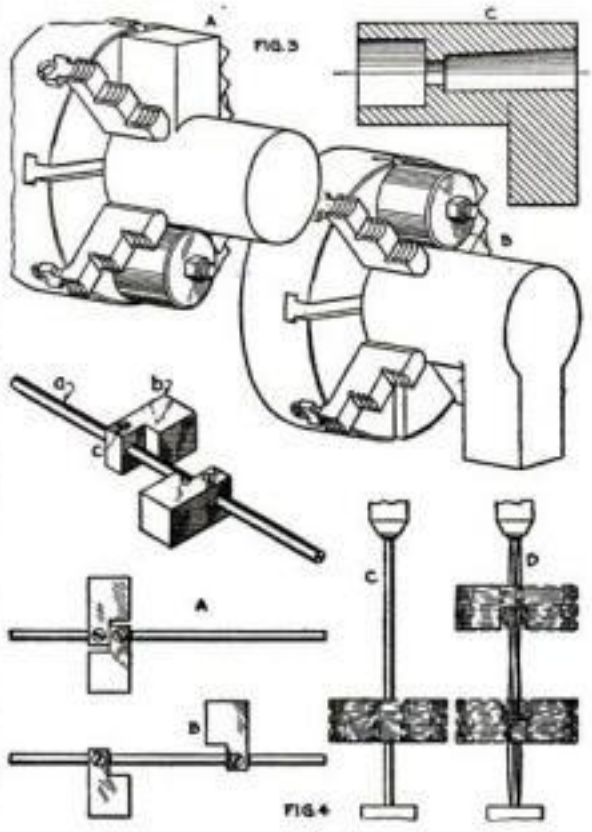
THE quick-change punch and die holder shown in Fig. 5 is one that I devised and have found after long tests to save time and stand up well under hard use.

Let us look at the die holder. Two drill rod pins project into the central hole as far as the depth of the groove in the die block. We drop the die block into the holder and turn it until the pins are in line with the two slots. The die block drops down and the pins will come in line with groove; a half turn either way locks the block in place. Needless to say all parts must be a nice fit.

The punch works on exactly the same principle. An automatic dog or gage should be used on the press treadle so there will be no chance of the machine starting while the operator is changing dies.—ALBERT E. BIRD.

Mounting Lathe Work

(Continued from page 92)



Diagrams to illustrate the difference between static and dynamic balance in setting up work.

at rest while we intend to have it balanced while it is being spun, we are adjusting it to conditions which may not exist at all while it is being worked. The "real" or dynamic balance *may* be the same as static balance, but the chances are that they *are* not.

The main reason why the engine in your car runs without the vibration of the ancient chariot of ten or even five years ago is that the crank shaft of the new engine is dynamically balanced. It is true that the lathe spindle as a rule runs much more slowly, but the unbalance as a rule is also enormously greater. As against fractional ounces in the crank shaft, there are often many pounds of unbalanced weight in the work in the lathe.

If you wish a practical demonstration of just what the difference in the two kinds of balancing means, you can make the experiment shown in Fig. 4—unless you are satisfied by merely studying the drawings. All you need is a foot or so of slender rod, say drill rod, *a*, and two steel blocks *b* of equal shape and size, made as shown so they will "dovetail" over each other, and each fitted with a set screw *c* so it can be held in any position along the rod *a*.

With the blocks placed opposite each other, whether in line as at *A*, or apart as at *B*, the rod and blocks will be practically at rest in any horizontal position. There will be no difference whatever between *A* and *B*. There is a very great difference in the behavior of the two set-ups, however, when the shaft is placed in the drill press, for instance, and the spindle started. Arranged as (Continued on page 110)

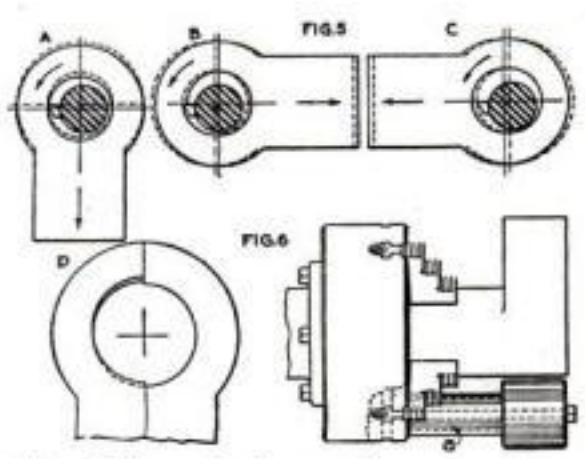


Figure 5 shows what happens when a set-up like B, Fig. 3, is used instead of one like Fig. 6.

Tool to Aid in Cleaning Machine Fixtures

Combination brush and scraper used for cleaning drill plates and machine fixtures.

DRILL plates and similar machine fixtures often accumulate hard spots of caked grease that cannot be removed with a brush.

One machinist made it a practice to keep a piece of tin handy for scraping the surfaces clean, finishing off with a brush, but the tin would be mislaid sooner or later. He then conceived the idea of attaching a scraper to the brush, as shown above.

Quick Way to Space Holes

How the collars were marked for drilling.

WHEN absolute accuracy is not essential, the method of marking off holes illustrated in the accompanying photo will be found quick and convenient.

The work shown is a collar, which is to be marked for five "tommy" holes. After chalking the bench plate well, I described a circle slightly larger than the collar, divided it into five parts, and marked five radial lines. All I had to do then was to lay each collar within the circle and pencil mark the five positions, after which I center punched the pieces ready for drilling.—ARTHUR KENDALL.

Mounting Your Lathe Work

(Continued from page 109)

at *A*, the rod and blocks spin smoothly, no matter how high the speed may be; but with the blocks placed apart, a heavy vibration sets in as soon as the spindle begins to turn. This vibration increases with the speed until the rod is visibly distorted two ways as at *D*.

It will be understood now why the casting of Fig. 3 is balanced right at *A*, and wrong at *B*. The fact that the casting is stiff does, of course, make a difference, but it does not do away with the fact that the weight is wrongly distributed at *B*. So long as the spindle is revolved slowly, as when the lathe is run through the back gears in turning the large outside diameter, there is, indeed, balance, because the work *is* balanced for gravity. It is not, however, balanced for centrifugal force, so that when the spindle is driven at high speed in boring the internal diameter, the hole will be both oval and out of center, as may be seen from Fig. 5, in addition to being tapering and at an angle to the faceplate, as at *C* in Fig. 3.

A good way to balance the part in the second position by using the same weight is demonstrated in Fig. 6. A piece of large pipe, *a*, turned square at the ends, is used to block up the counterweight. The weight must be rigid; if necessary, it can be strapped to the casting to resist the centrifugal force tending to move it outward.

The third article in this series will appear in an early issue.

How to Use Kalsomine

(Continued from page 78)

plaster; if it has some gloss, wash it down with hot water and a washing powder or sal soda to cut the surface a bit and then size it.

Old walls that are very dirty should be washed before the application of kalsomine, or the kalsomine will loosen the dirt, which will be smeared around, making dark streaks in the finish. Sometimes it is easier and cheaper to apply a coat of flat paint than to wash a very dirty wall.

Any holes or cracks in the old walls should be cut out with the putty knife to remove loose edges. Undercut the edges so the filling will wedge itself in place. Wet the cracks or holes with water and fill with a patching plaster or with ordinary plaster of Paris, smoothed over with a putty knife or soft wood paddle. When dry, coat the fillings with shellac to stop suction.

VARIOUS sizes are suitable for kalsomine finishes, but glue size is most commonly used. It is made by soaking flake sizing glue—say a pound—in a little cold water overnight. In the morning add one pail of hot water and stir the glue until dissolved, or work it with your fingers. If you are not sure that the glue is of a good strong grade, use a little less water. Some like to add also about a pint of table vinegar to make the size penetrate better.

Apply this size freely to the walls and ceilings with a kalsomine brush, taking care to catch up any runs or puddles in the corners. Let it dry at least overnight and longer if possible.

If a varnish size is wanted, make it by mixing together equal parts, by volume, of first-class floor varnish and turpentine. Then add a handful of fine pumice stone to give it a "tooth." Some like to add also a little flat paint to give color and thus help hide the surface to a limited extent.

Prepared kalsomines are sold in five-pound and larger packages. On an average one pound will cover about 100 square feet. Consequently, a five-pound package will cover with one coat an average room about ten by twelve feet with the usual eight-foot-six-inch ceiling height.

Follow the directions on the package in mixing the kalsomine. They may call for hot water or for cold. Lukewarm water is better for the so-called cold water kalsomines. If the directions call for boiling water, be sure to have it boiling hot, not just warm.

ONE of the first-class kalsomines is to be mixed in the proportion of four pints of boiling water to five pounds of the dry kalsomine. The water goes into the pail first in all cases of dry pigment mixing, and the dry pigment is then poured a little at a time into the water while the mixture is stirred well. Then, after dissolving, the kalsomine is allowed to stand until cold.

Such a mixture will be about as thick as cream when first prepared. It should be strained through cheesecloth while hot. When cool it will be thicker. It will "jell," as they say, and is ready to be brushed in that condition when the walls also are cold. In hot weather any kalsomine with a glue binder, if used in the cold jell condition, is apt to run or sag because of the heated condition of the walls. In order to avoid that trouble, it is best to use the kalsomine while it is still warm and before it has jelled.

When you want to mix two kalsomine colors together, it may be done while they are in the dry powder state or by mixing each color separately and then adding one to the other. Keep in mind that you cannot tell what color kalsomine is until it has been applied and is dry. It looks darker while wet than when dry. By mixing a little of the second color into the first, dipping a piece of cardboard in, and drying it over a stove or other source of heat, you can test the (Continued on page 118)

How to Use Kalsomine

(Continued from page 111)

color. Strain the mixed kalsomine while warm.

It is in the brushing that amateurs are most likely to get into trouble with kalsomine. This is because they are likely to try to brush it out, to stretch it out, like oil paint. A good kalsomine brush of the standard type or of the Dutch type is necessary, and it must be dry when you start to use it. A wet brush is too soft and flabby to work well.

Kalsomine should be flowed on freely and brushed as little as possible. Flow it on evenly, keeping the brush well filled. Take up a brushful, apply it to about one square foot, and let it alone. Follow with another brushful and join up the second patch with the first with a light stroke or two, using the bristle tips. Then let it alone. Do not go back to the first patch.

Repeat this action until the surface is coated. Use semicircular strokes. Start at the upper left-hand top of the wall and carry a stretch down the wall about one yard wide. After reaching the bottom, return to the top and carry down another stretch. Coat the ceiling first and use the same method.

As a rule only one coat of kalsomine is applied. A skillful brush hand can often "top-over," as it is called, with a thinner second coat after the first is dry. Sometimes it is necessary to apply a second coat of size on top of the first coat of kalsomine before topping over. The trouble is that the application of a second coat is apt to lift the first coat and reveal the bare wall unless the correct brush action is used—thin kalsomine and light strokes with the tip of the brush. Where good covering has not been gained, it usually is best to wash off the first coat and try again.

The finishing of walls with kalsomine in two- or three-tone effects is another story and will be discussed by Mr. Vanderwalker in an early issue.

Caustic Soda Found an Aid in Gluing Several Woods

STRONG glued joints can be obtained by treating with caustic soda certain species of wood which otherwise frequently produce weak or inferior joints, according to experiments made by the Forest Products Laboratory of the United States Forest Service. Joints of hard maple, yellow birch, white oak, red oak, red gum, black cherry, basswood, and osage orange wood treated with caustic soda showed a decided improvement.

A ten percent solution of caustic soda gave the best results. The wood surfaces to be joined were brushed with the solution and after ten minutes were wiped with a cloth to remove any excess. They were then allowed to dry before being glued.

In tests of hard maple glued with animal glue, the shearing strength (measure of the capacity of wood to resist slipping of one part upon another along the grain) of a piece of untreated wood glued under favorable conditions was 3,110 pounds, as compared with 1,570 pounds for an untreated piece in which "starved" joints were manifest, and 3,250 pounds for a piece treated with caustic soda solution, but glued under the same starved-joint conditions as gave a result of 1,570 pounds for the untreated wood.

Osage orange wood treated with caustic soda and glued with casein glue showed a shearing strength of over 3,000 pounds, as compared to a shearing strength of only 294 pounds exhibited by the joints of untreated wood.

Just why treating certain woods with caustic soda increases their joint strength when glued is not known. Evidently the caustic soda changes the surfaces of the wood fibers in such a way as to cause the glue to stick more firmly.

Furniture Polishing Secrets

(*Continued from page 106*)

to match other pieces with which it is to be used. This must be done with the first application of oil.

In using the penetrating wood dyes mentioned in the preceding article (brown mahogany is best for walnut and dark mahogany for mahogany; the other colors as recommended on the manufacturers' labels) add enough of the required color to the linseed oil, diluted as before, to give the wood the shade desired. Try it out on some unexposed part of the piece to be sure it is the right tone. Apply this colored oil as a first coat and the wood dye will dry in with the oil, imparting a permanent color which will take a rub finish. Carry out the finish as before.

Boiled linseed oil diluted with equal parts of turpentine is excellent for all wood except old curly maple, which it darkens too much. This is one wood on which gasoline or benzine should be used, in the proportions of one part

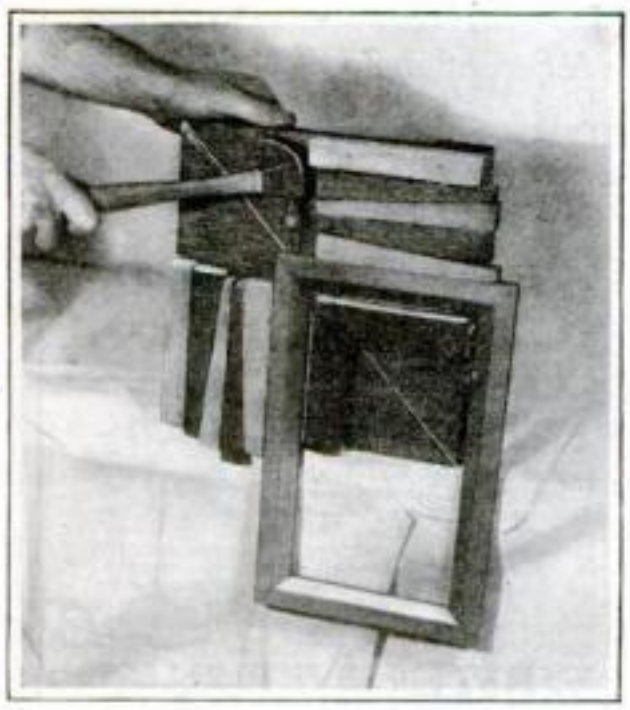


Fig. 4. Wedging up one joint of a small picture frame in a simply made wooden clamp.

linseed oil to three parts of the other. These liquids are highly inflammable.

A great number of antique pieces are found which have black spots and rings on their tops. Some would rather have these marks, while others will not have them at all.

If it is desired to remove them, proceed as suggested in previous articles as far as the first coat of oil. After this is dry, use a cabinet scraper to scrape out the spots and enough of the surrounding surface so that the scraped places do not show as holes dug in the wood. Apply the diluted boiled oil frequently to the parts being scraped. After the spots are removed, apply the modified French polish described above to the places scraped, and finish as before.

Cabinet scrapers should be burnished. First rub the edges on an oilstone until they are square across and a trifle crowned or convex in the center. To burnish, use a nail set, regular burnisher, or other suitable tool. Figure 2 shows the proper position of the burnisher in relation to the scraper. Burnish with a back-and-forth stroke.

Various wooden clamps have been described in previous articles. Figure 3 illustrates another. It is used to clamp up frames for nailing. The base in this instance is ⅞ by 11 by 11 in. It is made to hold moldings up to 4 inches in width. How the same clamp is used to hold a small frame is shown in Fig. 4.

If, when the members of the frame are clamped up, the joints do not fit, a saw kerf may be taken from the joint on the diagonal.

Mr. Stanley's next and eighth article will deal with the repair of old chairs.

Replacing a Broken Window Pane

Paste this Home Workshop Reference Sheet, including the head above, in your scrapbook in the section marked *windows*. (Jan., 1929, POPULAR SCIENCE MONTHLY.)

What are the steps in replacing a broken window pane?

NOTHING of equal size can more effectively give an air of general dilapidation to a room or to the exterior of a house than a broken pane of glass. The difficulties of resetting a broken light, however, need not deter anyone from attempting it. An old chisel, say 1 in. wide, and a putty knife are the tools needed. The only materials required are the glass, glaziers' points, which are small triangular pieces of tin or zinc, and putty, all of which may be bought at any hardware store.

1. Measure the size of the broken glass. Usually it will be of standard size and the space in which it fits is about ⅛ in. larger each way to allow for ordinary variations in cutting. We will not consider cutting the glass, for if it is not a stock size it will be cut at the hardware store when the putty and points are bought. If the pane is not a stock size, you will have to pay for the larger size from which it is cut. If the glass is 20 in. in either dimension, it is advisable to have it of double thickness.

2. When all tools and materials are at hand, take out the sash and remove the cords by methods described in a previous reference sheet (Nov., 1928). Take the sash to an unused room if possible, but if you must work in a family room, spread newspapers liberally, for the old putty will fly as it is cut out. Lay the sash putty-side up on the table and with the chisel cut the putty away from the sash and the glass. If paint remover or hot soapy water is put on the putty and allowed to soak for five or ten minutes, the putty will be softened to some extent;but workmen seldom do this, for the same treatment will soften the paint of the sash, which should not be disturbed. Remove the broken glass and cut out the putty bedding left in the side or bottom of the rabbet. Be careful that the wood of the sash is not cut or splintered, or it will be hard to finish the putty smoothly.

3. To be sure the glass will fit properly, try it by laying it in the rabbet, hollow side down. Every piece of ordinary window glass is slightly curved and if laid with the hollow side up, may break when the points are driven. If the glass is a little large, has a projecting point, or is not exactly square and does not drop into its place easily, do not cut the corner of the sash, but cut into the wood near the bottom of the rabbet, as at *Z* in the illustration on page 106.

4. Be sure that the putty is as soft as it can be handled; if too sticky, temper it by rolling it in whiting or flour and work it in the hands. First "bed" the glass by rolling putty out into a thin sheet ⅛ in. thick or less, as in Fig. 1. A rolling pin or bottle can be used to do this. Holding the glass as shown, with the inside face downwards, cut away an edge of the putty as at *A* to make a straight edge as at *B*. Place the edge of the (Continued on page 116)

Repairing a Window

(Continued from page 114)

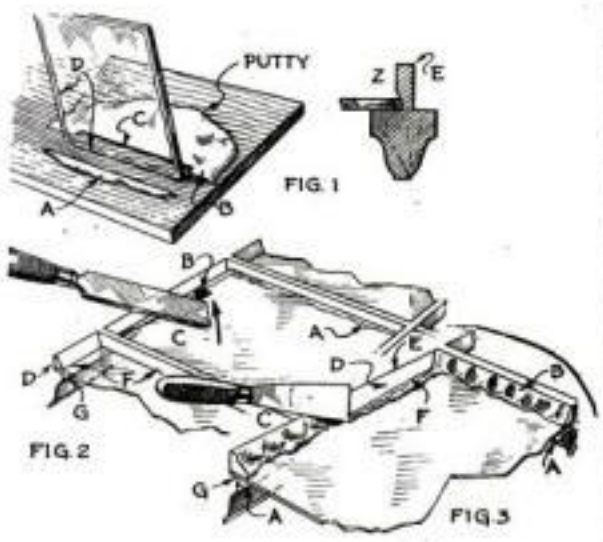
glass somewhat less than ¼ in. from the edge *B* and scrape off the putty as at *C*; do this all around the glass as indicated at *D*. Lay the glass into its rabbet, press lightly until the surplus putty between the glass and the rabbet is squeezed out as at *A* of Fig. 2 and Fig. 3. This must be done cautiously or the glass may be broken.

5. Place glaziers' points as at *B*, Fig. 2, and drive them with the chisel held as indicated until they project just enough to hold the glass and allow the putty to cover them when it is "run down." There should be at least two points on each side, and for a large glass they should be not more than 9 or 10 in. apart. Press the glass lightly as this is done and slide the chisel over the glass as at *C*, otherwise a blow from the chisel may break the glass.

6. With the thumb, press putty into the angle between the glass and the sash as at *B* of Fig. 3.

7. With a putty knife, "run down" the putty as at *C* of Fig. 3, making a smooth bevel, which will fill the corner as at *D* of Fig. 2 and Fig. 3. A little practice will cure the first awkwardness. If the putty knife is moistened in soapy water, it will slip over the putty smoothly. The corner of the sash at *E*, Fig. 3, will guide the knife if it is held at the correct angle; if *E* is without splinters and straight, a true putty bevel should result. Care must be used, however, that the glass edge of the putty at *F* does not project beyond the sash rabbet at *G*, or it will be seen through the glass from the inside. It is excellent practice to keep the putty edge a little back from edge of the sash rabbet.

8. Turn the sash over and with the putty knife remove the waste bedding putty *A* of



A thin strip of putty is placed on the inner edges of the glass as in Fig. 1; the glass is laid in the rabbet and held with glaziers' points as in Fig. 2; the putty is applied as in Fig. 3.

Figs. 2 and 3. A little whiting or flour dusted on the putty bevel will stiffen the surface and help it to harden.

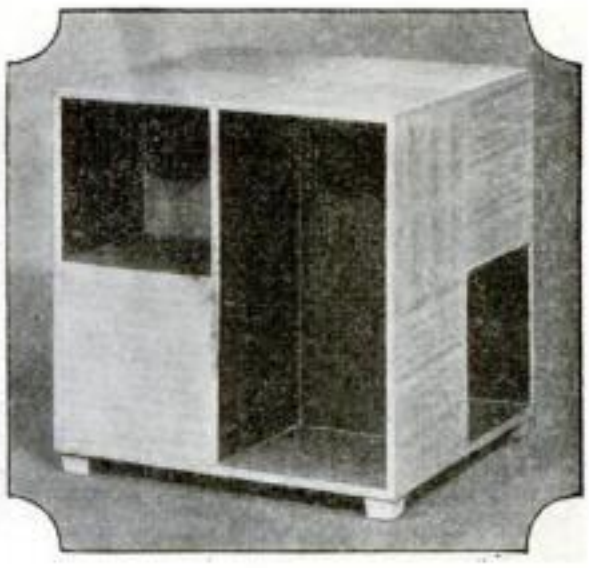
9. Clean evidences of putty from both sides of the glass with a soft cloth, being careful not to deface the putty bevel.

10. Reliang the sash and put the stop strips in place.

11. The color of the new putty will probably be different from the rest of the sash, thus telling all observers that a new light of glass has been set. After several days, in which the putty will become sufficiently hard, it may be painted.

The glass of outside doors may be set with putty, but often the glass of inside doors is set with beaded strips of wood nailed in place. These strips must be removed, the new glass put in without points, and the strips nailed in place. Glass in a door usually can be reset without removing the door from its hinges.

(Above)
Smoking Table
See LePage's Book, page 16



Modernistic Table
See LePage's Book, page 11

Lady Washington Sewing Cabinet
See LePage's Book, page 7

Clothes Drier Built Over Stairs

By DAVID O. WOODBURY

THE problem of drying the family washing during rainy days and in winter, when everything wet freezes the minute it is put on the line, often causes the housewife much annoyance. Particularly is her problem a difficult one when there are several small children for whom daily washing must be done.

The usual solution is to hang the washing on a clotheshorse indoors or on a line in the cellar or attic, but neither way is ideal. In casting about for some way to dispose of a large daily wash in a small single-family house, I hunted at considerable length for a place that would be out of the way, would allow the clothes to dry quickly, and would be beyond the reach of mischievous little hands. Finally I found such a place in the stair well. It is subject to a strong updraft of warm air in winter; it is perfectly clean; it is out of reach of the children; and it is out of the way and practically out of sight. As the space above the stairs usually extends to the ceiling of the second floor, there is ample height to hang the clothes where they will not touch the head of anyone going upstairs. Incidentally, the drier acts as an efficient humidifier.

It is only necessary to find something to hang the clothes on. This may be done somewhat as indicated in the accompanying sketch. Two upright pieces of wood are fastened to the banisters of the stair rail on the second floor. Across these pieces and fastened to the top of them is a horizontal rod with notches ½ in. deep and ⅞ in. wide cut at 6-in. intervals in its upper edge. A similarly notched piece is screwed to the stair-well wall opposite the first piece and on a level with it.

Next a set of crosspieces is cut from suitable lumber as shown and well smoothed with plane and sandpaper. These strips should be about ⅞ in. square in cross section and 4 in. longer

Rack for drying clothes placed over stairs to take advantage of updraft of warm air.

than the distance between the two horizontal pieces already mounted; they form the "line." Even when out of service, the strips are kept in position.

One wooden strip at a time is removed and the clothes hung over it while it is held in the hand. There is but one caution to be observed—to get the washing well wrung out before it is hung up.

If properly constructed so as to be rigid, the device will work remarkably well. On the average, a small piece of clothing will dry completely in half an hour in winter. The fact that the rising air is clean leaves the clothes unmarked.

The drier I built for myself has eight crossbars 4 ft. long, equivalent to 32 ft. of clothesline. Constructed of scrap lumber, it cost possibly fifty cents and took two hours to install.

Improving an Automatic Gas Range Lighter

AFTER an automatic gas range lighter has been in use for a while, it sometimes will cause almost unbearable fumes and make the bottoms of pots and pans sooty. Soon it becomes difficult to maintain a flame in the little pilot light. All of these troubles are due to the formation of carbon in the combustion chamber.

By cutting a hole in the lighter cap, the formation of carbon is prevented.

The remedy is easy. Simply cut a ¾-in. hole in the top of the lighter cap. This hole provides a pressure release when the button is pressed and prevents the flame from coming in contact with the metal parts of the cap. Soot and fumes are entirely eliminated.

If, when the push button is pressed, the pilot light is blown out or a roaring sound is heard, too much gas is being used. This condition can be corrected by means of a hexagon adjusting nut to be found under the button. Use a wrench to screw the nut closer to the button.

There is also a screw on the side of the fitting near the button to adjust the height of the permanent flame, which should be about ⅝ in. long under ordinary circumstances—JOHN H. SCHALEK.

A DURABLE quick drying putty is made by thoroughly mixing Spanish whiting in orange shellac until the mass is about the consistency of ordinary putty. I use this putty exclusively in pattern making. It dries hard and appears to have very little shrinkage.—W. O. ASCHERMANN.

Setting Up a Model Railway

(Continued from page 77)

result in irregularity and uncertainty of operation.

Take pains to see that straight stretches are really straight and that they will stay that way. This means that each section should be fastened to the floor or bench with screws. One screw close to each joint will do. Don't use nails. You will have trouble pulling them if you desire to make any changes.

Track can be laid straight by stretching a string an inch or two above the floor or bench and then measuring from the string to the nearest rail. This is a much better method than to rely on sighting along the rails.

Banking the curves at the ends of long straight stretches will help to prevent derailments. Start the banking on the straight section before the curve. Small pieces of wood under the outer ends of the ties will give sufficient bank and the screws that clamp the track will hold them in place. A banked curve is shown in Fig. 1. This curve is banked about five degrees from the horizontal.

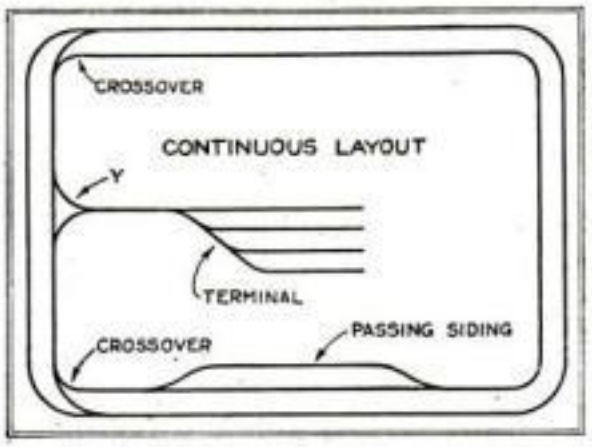


Fig. 5. This type of track layout allows trains to be run as in actual practice.

Avoid S-curves made by connecting two curved sections together. If you must have an S, insert at least three quarters of a straight section between the curves.

A TRACK layout that includes grades for the locomotive to climb will prove more interesting than a layout where all the track is on the level.

Do not make the grades too steep. The slightest amount of oil on the track will cause the locomotive driving wheels to slip, and the train will stall if the grade is too heavy. Real railroads rarely use a grade steeper than one in thirty, which means that the train climbs up one foot for each thirty feet of track. Any well-built model electric locomotive will climb such a grade and pull the usual number of cars without undue wheel slippage. The heavier double-motor locomotives will start a full train from a standstill on such a grade. Figure 2 shows a train climbing a grade of one in thirty.

Space limitations and the arrangement of your track layout may, of course, necessitate a steeper grade. This is permissible if the grade is short and there is a straight run at the bottom of the grade so that the locomotive can get a running start. Another way out of such a difficulty is to make the grade quite steep near the bottom where the momentum of the locomotive will help to carry it up. The upper end of the grade (Continued on page 118)

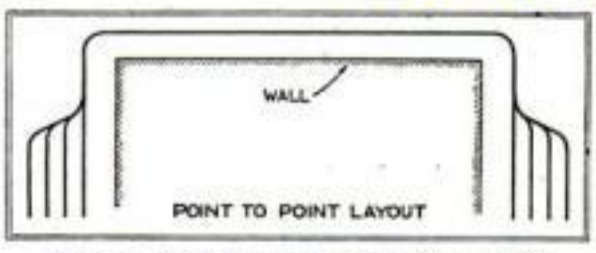


Fig. 6. A good arrangement when trains are to be run through a hall between two small rooms or in very narrow quarters.

Setting Up a Model Railway

(*Continued from page 117*)

should then be made a more gradual climb.

One of the simplest ways to install a grade is to take a single board the length of the grade and cut some short pieces, beginning with a 1-in. piece, then a 2-in. piece, a 3-in. piece, and so on. These can be placed at uniform intervals under the long board and the spacing between them will determine the grade. For a one-in-thirty grade, for example, the graduated supporting pieces should be thirty inches apart. If the board in which the track is fastened is 5 or 6 in. wide and ⅞ in. thick, the supports may be as much as thirty inches apart, but if a thinner board is used it will be well to double the number of supports by cutting them in ½-in. steps.

YOU may not be so fortunate as to be able to put your track down permanently. However, it is possible to make a satisfactory portable track layout, although of necessity it cannot be made as elaborate as a permanent installation.

Obtain from the nearest lumber dealer several sheets of plywood. The three-ply sheets a fraction of an inch less than ⅜ in. thick will do. Instead of fastening the track to the floor or a permanent bench, cut lengths of plywood to fit under the track. This will permit you to take up the track in long sections without danger of bending it. As plywood is limited in length, usually the maximum length of a single strip cannot be over 5 ft.

The terminal can be mounted on a single piece cut to the proper size. By carefully planning the breaks between sections, you will be able to build a track layout that can be taken up in sections and stored in a convenient closet in just a few minutes.

PORTABLE grades can be made just like permanent grades except that the plywood is used instead of a thick board and the supports will have to be attached to the track board by means of cheap iron hinges to allow the supports to be folded against the track board when you wish to store it.

Real locomotives with strings of passenger or freight cars behind them go by with a tremendous roar, so that the noise of a model train as it goes around the track is quite natural and realistic. However, the people living in the rooms directly under the floor where the model railway is installed may object to the noise. A permanent installation cannot be muffled to any noticeable extent if the track is fastened directly to the floor. Putting strips of felt under the track will not do much good because the vibrations still will be transmitted to the floor boards by way of the screws. The only practical solution is to mount all the track on boards just as though you intended to make it portable and then glue strips of felt under the boards. The felt will prevent any direct vibrations from being transmitted to the floor.

In a second article scheduled for publication in the February issue, Mr. Ryder will tell how to plan a control system for a model railway.

WHEN a tile in the bathroom or kitchen wall becomes loose, cracked, or broken, the handy man often wishes that he could make the necessary repairs himself. Excellent cements are sold for sticking loose tiles in place and the tiles themselves can be purchased. The main difficulty lies in cutting the tiles, if that is necessary, which often it is. No home worker is apt to have tile cutting nippers, but he can cut the tiles by scoring the glazed side with a glass cutter and then using pliers with parallel jaws to break off the part to be removed. A tile can even be cut cleanly in half by using the glass cutter on the face and then tapping the underside along the same line S. T. D.

Artistic Hinges

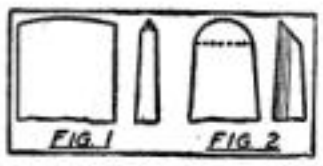
(Continued from page 79)

the piece were actually forged down from a thicker piece.

Large work should be placed between the vise jaws for filing down the cut edges, but between the jaws and the work should be placed some thick cardboard, copper, or even tin to prevent the jaws from marring the work. Do not forget that common chalk rubbed on a file will prevent copper sticking in the teeth to a large extent.

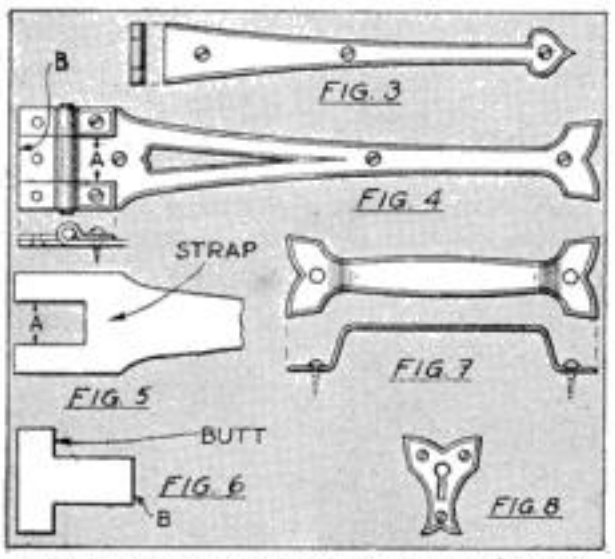
Small work and the cut-out spaces in the interior of large work may sometimes be filed to advantage by placing the metal flat on the bench pin where sawing is done and then filing it with an up-and-down motion. Coarse and fine emery cloth may be torn into narrow strips and, while the work is held in the vise jaws, pulled back and forth.

In making a key plate (Fig. 8), form the keyhole by first drilling a hole to take the shank of the key and two smaller holes at the bottom of what is to be the slot below. Then use the cold chisel to cut out the metal between the holes. Holes are, of course, drilled for the holding screws or escutcheon pins. File the rough edges up neatly, using your template as a guide, and then chamfer or round all edges. (Of course, you may saw out such small pieces as key plates and small hinges, but for large work the cold chisel is much quicker and easier. Sawing will be explained in a following article.)



Cold chisel and special chisel for curved cuts.

Sometimes, to avoid making a hinge joint, an imitation hinge is made by cutting out a separate arm or strap, so that it may be screwed next to a common butt hinge of brass or steel and appear as part of it. One such is shown in Fig. 3. The butt hinge used with



Hinge strap, complete hinge, pattern for cutting the hinge lugs, and handle and key plate.

this is usually electroplated and colored to match the finish on the strap, as are the screws or nails used to fasten the hinge. (Simple methods of electroplating copper, silver, and gold will be explained later on in this series.)

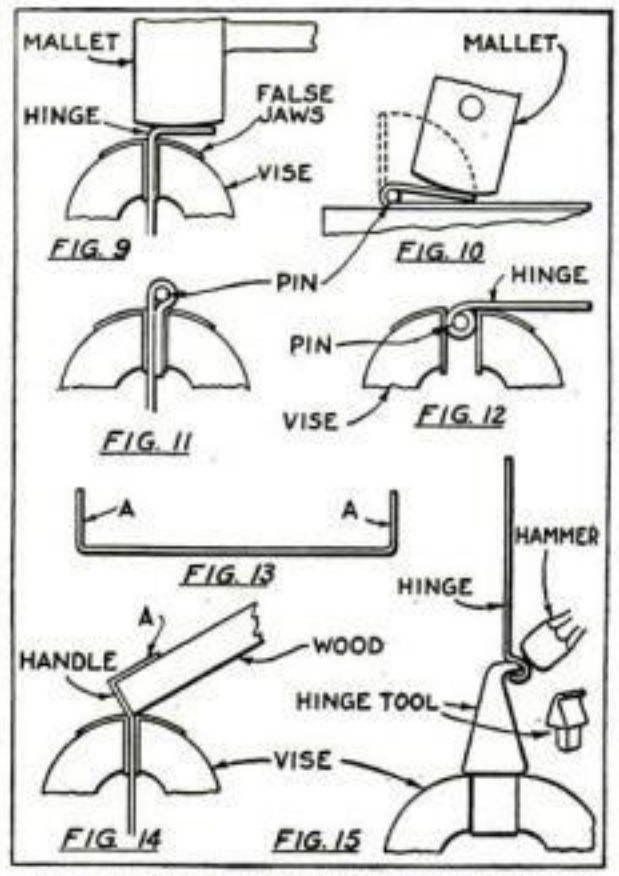
To make a regular hinge joint, like those used on commercial butt hinges, is a job beyond most beginners. There are other ways, however, to make a hinge joint rather simply. Such a joint and hinge are shown in Fig. 4.

When a hinge is made of soft metal, the pin on which the hinge turns should be larger than it would be if the hinge were made of a harder metal, such as hard brass or steel. The hinge shown is 9¾ in. long, and the pin used for it is about 3/16 in. thick, of Bessemer steel rod, but the shank of a large wire nail would have served. The lug *B*, Figs. 4 and 6, is planned so that it may be bent around the pin and lapped flat down against the butt plate, as are the lugs

(Continued on page 120)

Artistic Hinges

(Continued from page 119)



Steps in bending and forming hinge joints and making handles, and a special hinge tool.

A on the strap of the hinge. These lugs are actually held down by the screws which secure the hinge to the woodwork.

When the hinge is cut out, the hinge of the strap should be like Fig. 5, and the butt is made like Fig. 6 if it is to be mounted at right angles to the hinge strap. Frequently hinges are made where the butt plate is to be set flat, showing the whole shape of it. In this case the butt end is made larger and of a design to match the rest of the hinge. The butt end of the hinge shown in the lower left-hand illustration on page 79 is really made to be let into the woodwork at right angles to the hinge, but has been photographed flat in order to illustrate the construction.

Figure 9 shows how each lug is bent over at right angles. You will have to determine the position of the bend for yourself; the thickness of the pin and the thickness of the metal used will govern the position of it on the lugs.

The false vise jaws shown are made of No. 20 copper. A flat piece of copper as long as the vise jaws are wide, and wide enough to form a jaw, is placed between the jaws of the vise and hammered down to fit. Another piece of copper of the same size is then placed in the vise—the first false jaw remaining in place—and is hammered down. All sharp edges on both pieces should be well rounded over. You will find many uses for these jaws, as they prevent the rough scoring of the vise jaws from marring your work. Common sheet tin from a tin can may be used for this purpose; and for filing, false jaws made of cardboard are often used.

When the angles are formed in the lugs, place the work flat on the anvil surface, lay the pin in the angle, and hammer down the lug or lugs as in Fig. 10. A wooden mallet should be used. Next the work is placed between the vise jaws as shown in Fig. 11 and the vise squeezed up tight. During these forming operations it is well to have the pin 2 or 3 in. longer than it is to be finally.

When the hinge joint is formed, the pin is put in temporarily to see if the joint turns freely, and any excess metal is filed off.

When you are ready to place the pin in the hinge to stay, saw the pin off so that it projects about $\frac{1}{16}$ in. beyond each end of the barrel. Rest one end of it on an anvil and use a ball peen hammer to (Continued on page 121)

Artistic Hinges

(Continued from page 120)

rivet over the ends, riveting each a little at a time. Test the hinge joint as you rivet the pin, to see that it turns freely and that you do not bow the barrel out of line.

If you have had some experience in metal working and wish to make a regular hinge joint, you may proceed as described, but the excess metal of the lugs may be sawn off with a hack saw and the joint completed between the vise jaws as in Fig. 12. This takes some nice planning as to how much metal to leave; it is difficult to make a neat job. A hinge joint of this kind, if made of soft copper or brass, is usually silver soldered for strength on large hinges. Silver soldering will be described later on in this series.

PROFESSIONAL metal workers sometimes use a hinge tool forged from an anvil hardy as shown in Fig. 15. The lug or lugs to form the barrel of the hinge are first bent up at right angles; then the hinge is placed on the tool as shown and the joint hammered into shape. The joint made in the hinge shown in the central illustration at the bottom of page 79 was made in this way, but, frankly, it is a difficult operation.

Frequently small hinges for boxes and the like are made by soldering lengths of tubing to the two flat parts of the hinge and sawing and filing out alternate sections to form a hinge joint. Such work is usually silver soldered for strength.

When the handle, Fig. 7, is cut out and filed up, the flat metal may be bent into a handle form by first bending up the two ends, as at *A* in Fig. 13. The handle is then completed by placing each end in a vise (Fig. 14) and using a stick of wood and a hammer to drive down the metal to form the second bend. Wooden tools are often used in this way. The screw holes are usually drilled after the parts are formed into shape.

AN ATTRACTIVE finish was obtained on the hinge, handle, and key plate shown simply by heating the metal with a blowtorch to a grayish brown, then rubbing away parts of this finish with a rag charged with dry pumice powder, after which the work was lacquered with a clear lacquer. The colored lacquers used for home decoration may be used to finish metal, but thinner should be added to make them less dense in color, so that when they are brushed on the work, the pigment will settle in the hollow places. Even common house paint, particularly green, may be applied to copper or brass, parts of it being wiped away with a soft rag while wet.

For brass and steel work, brass or steel screws may be easily obtained, but for copper the screws usually have to be plated to match the copper. Common round- or flat-head wood screws of steel may be given a light copper coating by placing them in some old pickling solution—say nine tenths water and one tenth sulphuric acid—in which copper has been frequently pickled. The steel screws should be bright and clean. Brass screws may be given a light coat of copper by tying iron wire around them and placing them in the pickle.

Steel screws so treated should be washed in clear water, dried, and then lacquered immediately to prevent the steel rusting through the copper. Steel or brass screws so plated may not be colored with liver of sulphur, as this will eat off the thin coating; if they are to be colored to match a dark copper, it is best to touch them up with a dark colored oil paint.

The next article—on sawing—is scheduled for early publication. When complete, the series, which began in the November, 1927, issue, will constitute a complete course in art metal work.

A definite program for getting ahead financially will be found on page four of this issue

How to Turn Large Columns

By GEORGE H. WHITEAKER

OF THE conventional plans published for pedestals, jardinière stands, and similar turned pieces, very few are available for use in the average home shop because the columns are glued up in six or eight pieces. Many amateurs do not have the patience or equipment to make the necessary long hexagonal or octagonal joints.

Graceful pedestal any turner can make.

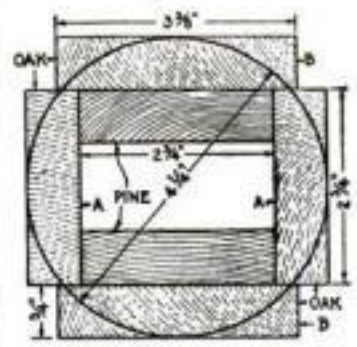
The job may be done by gluing one board upon another until the desired thickness is obtained; but the piece will be very heavy, there is considerable waste, and the last joint on either side, being at a very small angle to the turned surface, is likely to show rather plainly.

A surprisingly large circle can be turned from ¾-in. boards glued up boxwise. The corners will be rather thin when turned, but they can be strengthened by including a core of cheaper and lighter lumber. This is best done by gluing in two pine boards as shown in the drawing below. A column made in this way proves to be stronger than a hexagon column, it is a great deal easier to make, and the joints will be invisible if the work is well done.

It is wise to select quarter-sawed or edge-grain boards for this job, especially if oak is used. Flat grain material is very likely to splinter while being turned.

Plane the edges of two pieces of pine exactly 2¾ by 30 in. The dimensions must be exact and the edges straight and square. Do not plane the sides yet.

Pieces *A* are cut from hardwood to the same length. Leave them a little oversize, and be sure that they are full ¾ in. thick; ⅞ in. is better. Join pieces *A* to the pine boards first. This joint must be strong, but dowels are unnecessary. Use fresh glue, have the boards warm, work in a warm place free from drafts, and apply plenty of clamps, but do not pull any of them tight enough to warp the boards. Lastly, be sure the job is square.



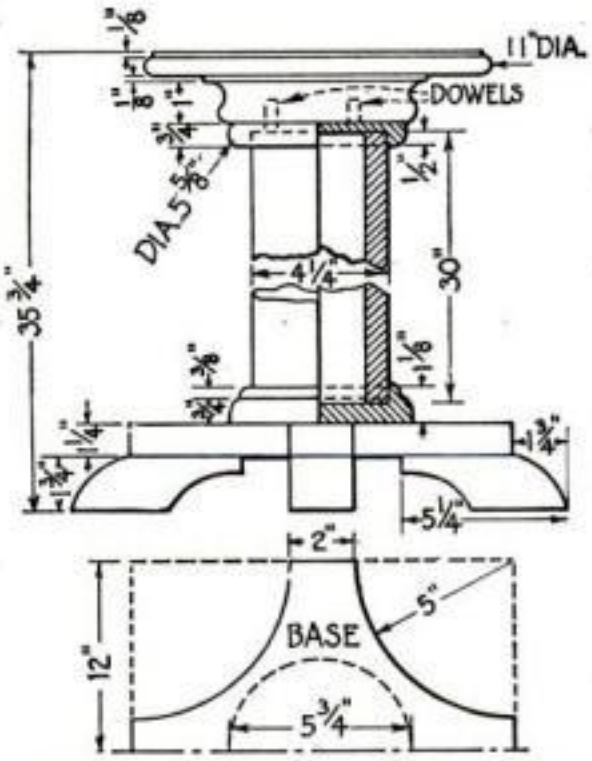
Boxlike method of gluing up a column for turning.

Let the glue set for twenty-four hours. Then smooth the pine sides. Pay extra attention to the oak edges; that is the part that will show your workmanship. It is a good idea to have the middles a hair's breadth low, to make sure of contact on the edges.

Plane the inner sides of pieces *B* with a smoothing or block plane just enough to remove the high lights left by the planing mill. Have the plane very sharp, set it just deep enough to touch the work, and stop as soon as the surface is smooth. Cut a groove ⅛ in. square down the middle and one ¾ in. from each edge of pieces *B* to take the surplus glue. See that they are correctly centered when assembling. Note that these pieces should be full 3⅜ in. wide, but not more.

AFTER the glue has set for forty-eight hours or more, plug the openings with a piece of scrap. Find the center of each end, check the location with a compass, and drill a small hole in each. Seat the lathe centers firmly and turn at slow speed. Such a piece will develop a tremendous centrifugal force if turned fast and may blow up.

There is ample opportunity for the expression of individuality in the design of the top and base for this piece. In any case, each end must begin with a collar. The one at the bottom is best made of 1⅛-in. material.



Working drawings of the turned pedestal shown in the photograph reproduced above.

In building up the top, glue a piece of paper between the collar and the next board. Mount the piece on a large faceplate and turn out the desired design. Turn the collar to a depth of ½ in. and fit snugly to the end of the column. Drill holes for two short dowels and then take apart by splitting the paper. Fasten the collar to the column with screws and glue; then attach the rest of the top, using the dowels for guides.

The base may be made in the same way or band sawed to the design illustrated.

Begin the finishing process by sanding with the grain until all rings are removed. Stain, fill, shellac, and varnish as usual.

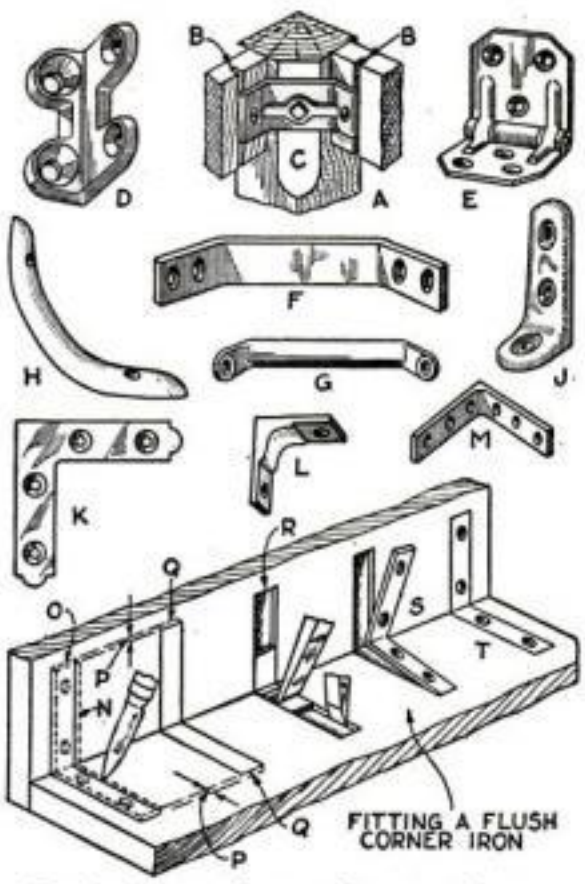
Hints on Applying Corner Braces

By DAVID WEBSTER

MANY products of home industry would last longer and be more worthy of their makers' pride if a few corner braces were fitted at strategic points in their anatomy. The accompanying illustration, which shows a few types of the common braces found in almost every large hardware store, should suggest their value to the home worker, and the obvious ease with which they may be installed should encourage their use.

Brace *A* is designed especially for building tables, stools, piano benches, and the like. Dowels are used in the joints between the rails and the legs merely to hold them in place while being assembled. Slots are cut as at *B*, and the back of the leg is cut away as indicated at *C*.

Braces *D* and *E* may be used for tables, cabinets, and other pieces where they may



Standard types of corner braces, and steps in setting an angle iron flush with the wood.

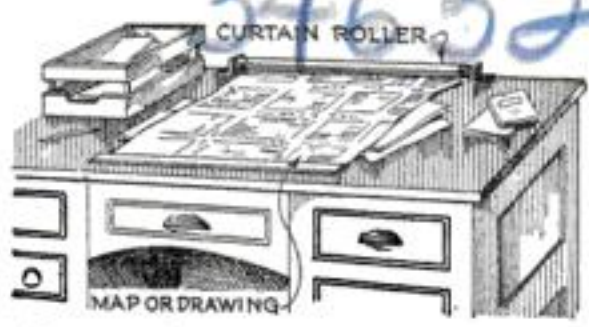
be placed out of sight under the top of shelves. Braces *F* and *G* will give excellent service upon chairs, heavy bookcases, and cupboards, where they can be effectively placed, for they are designed to resist racking strains.

Brace *H* is of bent wood, usually oak or maple, and is suitable for reinforcing chairs. It may be placed wherever it will function as part of the design.

At *J* is shown a very strong, rigid brace; two of these at the back of each end of each table rail where it joins the leg will insure stability. Often they are placed where a large iron could not be used but where strength is required.

The brass braces *K* and *L* are well finished for use upon work where they will be in sight. Black irons similar to *K* are often placed out of sight for bracing and holding corners, usually *(Continued on page 124)*

Mounting a Map on a Desk for Ready Reference



No matter how many papers are spread on the desk, this map can be consulted instantly.

HAVING constant use for a city street and house number map in a city health department, one of the office secretaries suggested that the map be mounted on cloth and placed on a curtain roller, which was attached to blocks clamped to the back edge of the desk. When needed for reference, the map is pulled across the top of the desk without disturbing any papers and books that may be already in use.—V. HAMMOND.

Steam Heater for Mash

Pail converted into poultry mash heater.

STEAMED mash aids in obtaining more eggs from hens during the winter. A simple heater for the mash may be made from a large pail and a disk of sheet metal slightly larger than the bottom of the pail. In the disk are punched a number of holes for steam. An inch or so of water is placed in the pail and the disk fitted above it. The upper part of the pail is filled with mash. The heater is then placed on a stove and the water brought to a boil.—E. R. SMITH.

Applying Corner Braces

(*Continued from page 125*)

being sunk flush with the surface, while *L* is placed with due regard for both strength and appearance.

The corner iron *M* is a common type, which may be sprung to fit various angles. Often it is simply laid on the wood and the screws driven home, but it is better to sink it flush with the wood. Be sure the edges of the iron are filed square if they are rounding, otherwise they will not fit well. Lay the iron in position as shown by the dotted lines at *N* and mark both sides of the corner deeply and accurately with a sharp knife point. Set back from ends *O* the thickness of the iron as at *P;* mark the ends as at *Q*, and cut the slot with a chisel as at *R*. Place the iron in the slot as at *S* and drive the screws. If the slot is too deep, build up with cardboard to be sure the face of the iron will be flush with the wood as at *T*.

Many discarded pieces of furniture may be restored to service by using braces.

Fighting Skipper of Air

(Continued from page 32)

often our language proved a bit too much for him and he slipped back into his native tongue.

"Well, you know," he began, "that the weather over the Atlantic in the last few weeks had been very bad. So I had to make a special kind of trip. I could not go right out straight across the Atlantic, and yet I felt I must go, once our ship was completed."

He took a couple of puffs at his cigar and went on:

"I was bold. I was bold enough to say that the weather would not keep me from starting out as soon as the ship was finished. That put me in the position of either being a liar or making the trans-Atlantic voyage. So go we did. But because of the weather over the ocean, we had to go by way of Spain and Gibraltar, and that added 1,200 statute miles to the journey! From Gibraltar by the way we came, near the Azores, it was a little more than 5,000 miles to our destination in America."

I WANTED to know the details of the accident that tore the fabric from the lower side of the port fin, in the repair of which four members of the crew, led by Dr. Eckener's own twenty-four-year-old son, Knut, covered themselves with glory. It was evident that the Commodore did not deem this occurrence worthy of much mention.

The storm Dr. Eckener called "a squall," and to the mishap which brought a message to the United States Navy to stand by with rescue ships he referred as "a little accident."

"Well," he said, "we were struck by wind as we went along smoothly at seventy-five miles an hour, with every motor turning perfectly.

"There was a sudden increase in the wind and rain came with it—a real squall. The *Graf Zeppelin* shot upward to an angle of forty degrees or so. The young helmsman on duty tried to bring her back to a horizontal plane, and in doing this he put a sudden strain on the stabilizer and that burst the fabric.

"The stuff caught in the wind. It was ripped away for something like a hundred square yards. Of course, it had to be repaired at once or more of the covering would go.

"It was a little accident," Dr. Eckener continued. "It never happened before in the history of Zeppelins and it can never happen again! Naturally, we were handicapped by it. It happened at eight o'clock in the morning and the trouble was fixed at one o'clock in the afternoon. In those five hours, we stood almost entirely still. And even after the repairs had been made we could only proceed at half speed."

HERE I interrupted.

"Tell about the repair job! Wasn't your son one of the riggers who went up to fix it?" I asked.

The Commodore's face glowed with unmistakable parental pride and pleasure. "All right, then," he smiled; "all right."

But this was a rather personal matter, and the English words refused to come easily. So he told me in the most polished German how Knut and the three others had repaired the damage.

As he talked, I saw an intensely dramatic picture of four young fellows running up the cat-walk into the tail of the ship, scampering up the girders of the frame that meets the fin at that point, and then, one by one, armed with shears and knives, mere pygmies in comparison with the monster whose wound they set out to bind up, climbing out over the ocean on the spars that make up the frame of the fin, clear out thirty feet along the duralumin beam, with nothing between them and the roaring, storm-swept Atlantic but 1,500 feet of air!

Clinging desperately to their perilous perch, beaten by storm and rain, tossed up or down fifty or a hundred (Continued on page 126)

A definite program for getting ahead financially will be found on page four of this issue

Fighting Skipper of Air

(*Continued from page 125*)

feet and climbing back and forth as the tail of the Zeppelin swung on the fickle wings of the wind, they succeeded in cutting away the hanging shreds. They never stopped for a moment until the job was finished—fully five hours with no let-up in the storm.

But Captain Flemming, who was at the controls in that soul-trying hour, told me a slightly different tale.

Knut was the first to volunteer. When he and the three others had crawled way back to the damaged fin and the *Graf* was practically standing still, Flemming turned to the Commodore and said:

"We must start two engines."

Dr. Eckener knew that if he ordered the motors started the wind might tear his son, and perhaps the others, too, off that precarious place and hurl them to the waves below. But the stern of the ship was beginning to sag under the deluge of rain, and so he also knew that he must move to try to maneuver out of the "squall."

"I MUST have two motors," Flemming repeated.

The Commodore's face suddenly grew very old. He looked out of the window in his favorite corner of the bridge. He swallowed hard. There was no telephone communication between the bridge and the fin, where Knut hovered between clouds and water. Then he said huskily:

"Start the motors!"

What Dr. Eckener went through from that minute until his son climbed down to the control room five hours later to report that the repairs had been made, only he and Heaven know.

"Were the passengers frightened?" I asked Dr. Eckener.

"To tell you the truth," was his reply, this time again in English, "I was so busy on the bridge that I hadn't time to go into the passenger-cabin to find out how the passengers felt.

"I did so as soon as we were under way once more. I found them calm, and reassured them as to the rest of our trip. Then we got out a bottle of nice wine and had a little toast and we all felt happy again."

But a somewhat different version of what happened right after the fin had been fixed was given me later by one of the passengers.

"YOU know," said this man, "Dr. Eckener had a pet canary aboard, whose double function it was to sing to him and to act as a gas-detector. The Commodore seemed unusually attached to this bird. Now, the moment Knut had come down and reported that the stabilizer was all right again, Dr. Eckener left the control cabin and went aft to look after his canary. He found the bird in high spirits, singing away at the top of his voice, and he calmly fed him. As a matter of fact, we passengers had been greatly upset, but when we heard about this, our fears were put to rest."

As Dr. Eckener was finishing his story of the voyage in the flight office, somebody handed him a slip of paper. It was a radiogram, but as it was penciled hastily in English, he handed it to one of the bystanders for translation.

It proved to be a message from Dr. Eckener's wife.

"She sends love and congratulations on your birthday," said the interpreter.

It then developed that the radiogram had been delayed for some reason and that the Saturday when the "little accident" in mid-ocean occurred had been Dr. Eckener's sixty-fifth birthday!

Dr. Eckener told me of his views regarding the future of trans-Atlantic dirigible transportation and of the lessons his recent experience taught him. (*Continued on page 127*)

Fighting Skipper of Air

(Continued from page 126)

He predicted the establishment of a regular airship service between the United States and Germany in three or four years, with a dirigible leaving from each side of the Atlantic every five days and making the crossing in between forty-five and fifty hours!

But to make such a service possible, he said, a capital of $14,000,000 will have to be raised for the building of four Zeppelins—two in this country and two in Germany—and the construction of two hangars, each large enough to harbor two of the giant ships at one time. Of the required sum of $14,000,000, the building of the dirigibles would take $8,000,000, and the balance of $6,000,000 would be necessary to erect the hangars.

THE Commodore then stressed the fact—which he was to emphasize again in Germany later—that his voyage in the *Graf Zeppelin* had shown him that speedier ships will be required for regular transoceanic traffic.

"The airship of the future," he told me, "will only be slightly larger than the *Graf Zeppelin*, but it will be more swift. It will develop an average speed of eighty or eighty-five miles an hour, preferably eighty-five. It will carry but few passengers and will be chiefly used for carrying mail and merchandise."

Dr. Eckener also admitted that the trip had taught him that stronger fabric must be used for the stabilizing fins and the tail.

The Commodore's forecast regarding the creation of a regular Zeppelin service, though perhaps not quite so sanguine, was in line with enthusiastic views he expressed a little more than a year ago, when he made his last previous visit to the United States. At that time he came and went by steamer and remained in this country only a short while to complete some business arrangements.

Then he visualized a dirigible trip around the world in twelve days—a dream that may well have caused the late Monsieur Jules Verne to turn in his grave!

Although his short sojourn in the United States in 1927 was little known publicly, Dr. Eckener is by no means a stranger to America and Americans.

When, in October 1924, the time came for the delivery flight of the *ZR-3*, now the *Los Angeles*, to the United States, Commodore Eckener himself took the controls and acted as commander of the ship on the voyage from the hangar at Friedrichshafen to the Naval hangar at Lakehurst. This was the longest nonstop trip ever made by aircraft up to that time.

UPON his arrival here, the Commodore won instant popularity, and on his return to his native land, he found himself received with all the enthusiastic honor and acclaim usually reserved for a triumphant war lord! He was repeatedly mentioned for the German ambassadorship to the United States and even for the Presidency of the German Republic. But he smilingly though steadfastly declined these high distinctions.

"My life," he said, "is bound up in the building of airships. I am not a diplomat nor a politician."

And he was right. At least, the last twenty-eight years of the Commodore's remarkable career have been devoted to the development of the dirigible as a means of safe and swift transportation.

It was in 1900 that the meeting took place that proved the turning point in Dr. Eckener's life. On the shores of Lake Constance, near the Swiss-German border, where he had decided to settle down as a writer and publicist on subjects related to economics, his specialty up to that time, the Commodore became acquainted with Count Ferdinand von Zeppelin, inventor of the dir-

(Continued on page 128)

A definite program for getting ahead financially will be found on page four of this issue.

Fighting Skipper of Air

(Continued from page 127)

igible that bears his name. There began a friendship that endured until the Count died seventeen years later. On almost daily walks along the beautiful blue lake, the Count, who already had begun to build rigid airships, expounded his theories and hopes.

For a long time, Dr. Eckener, an eminently practical soul, remained skeptical. But at last he became convinced of the soundness and practicability of the Graf's ideas, and he joined the Zeppelin organization.

Now Dr. Eckener, though an economist, was a navigator by nature. His talents along this line and his extraordinary gifts as a meteorologist became of great value to Count Zeppelin, and the subsequent development of airship operation was largely due to his efforts.

HUGO ECKENER was born in Flensburg, in Schleswig-Holstein. As a boy, his passion was the sea, and much of his leisure was devoted to navigating a small sailboat over the choppy waters of the Baltic Sea. Even as a lad of high school age, he enjoyed some fame for his courage and resourcefulness as a sailor and his skill as a meteorologist. For this youth, in some unknown fashion, had developed an unusual and almost uncanny ability to forecast the weather.

But the sea was not to be his career. The Eckener parents had determined that Hugo should become a man of science—a Herr Professor!—and to college he was sent. Here he specialized in economics, in which subject he took his doctorate with honors, a circumstance that explains his present thorough grasp of business and financial problems.

He also studied psychology at the University of Leipzig, which conferred a doctor's degree upon him in that subject.

All of the airship pilots in Germany were trained by Dr. Eckener, and in 1912 his work was extended to cover the commercial operations of the Zeppelin organizations under a subsidiary company called "Delag," of which he was made director.

During the two years just previous to the World War, Delag ships carried some 35,000 passengers and many tons of freight and express without a single accident.

COUNT ZEPPELIN died in 1917 and was succeeded by his nephew, Baron von Gemmingen, who passed away in the spring of 1924, when Dr. Eckener was made the third presiding head of the Zeppelin organization.

During the war, the Friedrichshafen plant had been built up to a capacity of one dirigible every two weeks! The technical problems surmounted at that time by Dr. Eckener, who throughout the period was Count Zeppelin's right-hand man, were the more complex because of the shortage of materials in Germany. Immediately after the war, it was thought at first that the Zeppelin plant would be destroyed. It was shut down, and Commodore Eckener was heartbroken.

It was not until after the famous flight of the *ZR-3* that the fate of the plant was finally decided. France insisted that it be destroyed. The German patents passed to the Goodyear-Zeppelin Company, of Akron, Ohio, at that time, and the Zeppelin works lost many of its secrets.

But the last few years of phenomenal aircraft development gave Dr. Eckener new hope of a real future for the plant, and on the wave of world-wide enthusiasm for aviation, he began the construction of his masterpiece—the *Graf Zeppelin*.

The enormous sky-ship embodies all of Dr. Eckener's theories of dirigible transportation. It is the fruit of his quarter of a century of experience as a builder of great aircraft. Into it he has put all his skill as an engineer, all his genius as a designer of lighter-than-air vessels.

Half a Billion New Stars!

(Continued from page 21)

lying right in the middle of the Milky Way.

Among the strangest mysteries of solar space are the stars that appear to "run up a fever" at certain times, become flushed and bright for a period, and then sink into dullness again. One of these is Algol, the "Winking Demon Star," whose secret was solved only recently. Exactly on the minute, every two days, twenty hours and forty-nine minutes, it suddenly begins to fade away, until in the course of three or four hours it loses four fifths of its light. A few minutes later it begins to brighten and, after three or four hours more, regains its former brilliancy. The puzzle was solved when a German astronomer showed that what seemed to be one star was really two, one of which periodically eclipsed the other. This was the first explanation of the mystery of a "variable" star (one that varies in brightness). Six hundred new variables were discovered last year. Many of them have been shown to be but a single star, and the solution of the puzzle of their periodic brilliancy is one of the celestial enigmas awaiting solution.

ONLY the other day the Belgian astronomer, M. Delporte, reported that near Jupiter he had discovered seven nameless little planets whirling on their orbits. Again, when a moving point of light, labeled on the star maps RZ Cephei, was clocked in a race against time, astronomers discovered that this star habitually tears along the speedways of the sky at the rate of 2,500,000 miles an hour!

The mention of such a distance is less startling than it was a few decades ago, when the universe was thought of as being not more than 45,000 light years across. Now we are told that the distance across the whirling arms of a single spiral nebula in the constellation Andromeda measures 45,000 light years, and that that "island universe" is a million light years from the earth!

Before we can comprehend figures so vast, we must seek some comparison in our everyday lives. If you begin counting the seconds ticked off by your watch, and count night and day, almost two weeks will pass before you can reach one million. If you count steadily for a year, you will arrive at a figure of something over thirty million. And during each one of those seconds, light travels 186,000 miles. Thirty million times 186,000 gives the number of miles contained in one light year—approximately six trillion. And that is but one unit of the millions and billions of which astronomers speak. It is believed that the new 200-inch telescope may penetrate into space a billion light years!

SO GREAT are these immense spaces separating the heavenly bodies that we never really see any of the stars where they are. We only see where they have been. By the time the light rays reach us, the stars have moved on in their orbits. Students of the stars say it is entirely possible that at this moment rays of light are millions of miles out in space on their way to the earth from stars that no longer exist!

A little over a decade ago an astronomer estimated that a cube one seven thousandth of an inch in diameter—so small it could fly into your eye without bothering you—thrown into Lake Erie, would occupy the same amount of space in that body of water that the earth occupies in the known universe. Yet the new telescope is to increase the size of that universe eightfold!

However, its greatest worth may lie in drawing our neighbors of the sky closer to us. The moon, for example. Already the Mt. Wilson telescope makes the moon appear less than 100 miles away, gives a photograph in which it appears to be thirty inches in diameter, and shows as much detail as (Continued on page 130)

Ⓢ This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 12.

Half a Billion New Stars!

(Continued from page 129)

is revealed by a nine-foot map of the world.

When Mars comes under its observation, according to Dr. H. N. Russell, Princeton astronomer, the surface of that planet will be seen so clearly that we can tell if the weather in a certain spot is warmer or colder than it was the night before! He says a nightly "weather map of Mars" is entirely possible and that the much-discussed "canals" and other features of the planet may be examined in great detail. It is entirely possible that the new telescope may at last give conclusive proof concerning the fascinating possibility of human life on other planets. For the detail with which a planet is seen depends upon the amount of light gathered by a telescope, and the 200-inch reflector will have a light-gathering power more than 300,000 times that of the human eye!

POPULAR interest in astronomy and its future soon is to be further increased by a "Theater of the Sky" to be erected near the Field Museum, Chicago. Max Adler, a Chicagoan interested in astronomy, has donated a half million dollars to build this first of American "planetariums."

A huge dome, ninety feet in diameter, forms a heavenly vault upon which the celestial drama is enacted. The audience, entering the theater, sits in a circle about a curious-looking object in the center of the room, consisting of a stubby glass cylinder, with knobs at each end, mounted upon a rotating mechanism. The audience notes that each of the knobs is studded with lenses. Now the lights of the auditorium are dimmed and the bare white vault above assumes the shade of a blue nocturnal sky.

A switch is thrown and powerful electric lights flash on behind the lenses, each of which project, magic-lantern fashion, a star or planet upon the dome above. Slides in the 119 lens projectors in the two knobs make it possible to show 4,500 stars, each revealed in the exact size and brilliance with which it appears in the actual sky. It took twelve years of experimenting for Dr. W. Bauerfeld, engineer at the famous Zeiss optical works, at Jena, Germany, to perfect the remarkable machine.

THE cylinder, with its knobby ends flashing their images upon the dome, moves slowly on its axis, duplicating the seeming diurnal roll of the heavens, while a lecturer tells of the romance of the familiar stars, pointing them out with a beam of light as he talks. The sun, moon, and stars ascend in the east and descend in the west, each represented with scientific accuracy as to relative distance and brilliancy. The panorama of the stars in the southern hemisphere, or a duplicate of the celestial bodies as they will appear to the Byrd expedition on the Antarctic ice packs, may be flashed upon the dome of the planetarium as well.

The rotation of the planets may be speeded up so that 26,000 years may be condensed into four minutes. The dramatic effect of the changing seasons, as reflected in the action of the heavenly bodies, is heightened by the mechanism which speeds up the action as much as 4,000,000 times. The stars may also be placed in the exact position they are expected to assume ten thousand years hence, or in the position they occupied when seen by Cleopatra on the Nile or by the Cro-Magnon man peering from his cavern home.

Planetariums similar to the one for Chicago have been established in a dozen cities in Germany and are in the process of construction in Italy and in Soviet Russia. New York has discussed the possibility of building one. Within the next few years, the building of the Chicago planetarium and construction of the observatory in California to house the world's largest telescope are expected to stimulate new interest in America in this oldest of sciences—astronomy.

Links in the Chain of Science

(Continued from page 49)

ingenious device, costing only $20, is attached to a wing of the plane and draws off the exhaust gases, using them to create a near-vacuum in which all noise is practically deadened. The silencer is constructed in such a manner that rarefied, whirling air is driven deep into the engine and acts as a cooler. The use of his device, Carlen says, does not diminish the power of the motor, but rather increases the number of revolutions per minute.

The silencing of the propeller is more difficult. Considerable success is reported in secret trials in France with six-bladed metal propellers instead of the ordinary two-bladed wooden propellers. A plane so equipped and with external wires and projecticns removed as far as possible is capable of practically noiseless flight.

THIS question of noise is attracting more and more attention from scientists as population tends to congregate in cities and towns and transportation systems multiply; for eighty percent or more of city noises arise from automobiles, electric railways, and steam roads. Dr. F. C. Dockeray, professor of psychology at Ohio Wesleyan University, reports that a little noise may act as a stimulant, like a cocktail or a cup of coffee, while too much noise long continued might send a person to an insane asylum.

But whether or not noises stimulate us, they are annoying; and at the Massachusetts Institute of Technology, Luther A. Gaw, of Cincinnati, has just announced an automobile engine that is reported to be virtually noiseless. His is a four-cycle engine with a single sleeve valve. It has fewer working parts than any other similar engine. It is shown in a photograph on page forty-eight.

The man who asked "What's the good of science?" probably sees no great value to humanity in the study of the whale's method of disposing of the carbon dioxide generated in the blood during long periods under water which is being undertaken by Dr. A. Brazier Howell, anatomist of the Johns Hopkins faculty. But this is a secret, which, if it can be discovered, may be of tremendous benefit to man. A whale can remain under water without breathing for an hour or longer. In the case of any other warm-blooded animal, suspension of breathing for that period would cause death from the carbon dioxide which would be stored up in the blood because it could not be exhaled through the lungs. An understanding of the chemical adjustment which must take place in the whale's body to enable the animal to consume its own poisons may lead to the discovery of some chemical method of life-preservation in submarine and mine disasters.

ONE could go on almost indefinitely piling up answers to the question "What's the good of science?" for scientific discoveries and their applications in the industrial arts are multiplying so rapidly that no single brain can possibly grasp more than a fractional part of the new knowledge that the world is gaining. The best that anyone can do, outside of his own special field of activity, is to glance at the "high spots" of science and invention, as they develop. And this is sufficient to demonstrate that the efforts of science are practical in the extreme, and are constantly reaching wider fields of usefulness and increasing the comfort and happiness of all men.

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OLD Money Wanted. Will pay $100.00 for 1894 Dime, S. Mint., $50.00 for 1913 Liberty Head Nickel (not Buffalo). Big premiums paid for all rare coins. Send 4c for Large Coin Folder. May mean much profit to you. Numismatic Co., Dept. 104, Ft. Worth, Tex.

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PATENTS—Time counts in applying for patents. Don't risk delay in protecting your ideas. Send sketch or model for instructions or write for FREE book, "How to Obtain a Patent" and "Record of Invention" form. No charge for information on how to proceed. Communications strictly confidential. Prompt, careful, efficient service. Clarence A. O'Brien, Registered Patent Attorney, Security Bank Building (directly across street from Patent Office), Washington, D. C. (See page 149.)

PATENTS. Booklet free. Highest references. Best results. Promptness assured. Watson E. Coleman, Patent Lawyer, 724 9th Street, Washington, D. C.

UNPATENTED Ideas Can Be Sold. I tell you how and help you make the sale. Free particulars (Copyrighted). Write W. T. Greene, 811 Baltic Building, Washington, D. C.

PATENT, trade-marks, copyrights. Reliable services by an experienced practitioner devoting personal attention to each case. Inquiries invited. References furnished. B. P. Fishburne, Patent Lawyer. 525-C McGill Building, Washington, D. C.

LANCASTER AND ALLWINE, 232 Ouray Building, Washington, D. C. "Originators of the Form Evidence of Conception." Before disclosing your invention to anyone send for blank form to be signed and witnessed. Form and patent information bulletin free.

ADAM E. FISHER, Registered Patent Attorney in business 30 years: references; personal attention and promptness assured; Dept.—E—183 Enright, St. Louis, Mo.

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MONROE E. MILLER, Ouray Bldg., Washington, D. C., Patent Lawyer, Mechanical, Electrical Expert. Booklet and Priority Record blank gratis.

Patent Attorneys

PATENTS Procured. Trade Marks Registered.—A comprehensive, experienced, prompt service for the protection and development of your ideas. Preliminary advice gladly furnished without charge. Booklet of information and form for disclosing idea free on request. Irving L. McCathran, 705 International Bldg., Washington, D. C., or 41-Z Park Row, New York.

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PATENTS—Free instructions. Former Patent Office Examiner. Moderate terms. Booklet. Albert Jacobs, 723 Barrister Bldg., Washington, D. C.

PATENTS procured at reasonable rates with time to pay. Sales negotiated. Staff of registered attorneys and engineers. Write for particulars. Inventors Service Bureau, Box 1648, Washington, D.C.

PATENTS—Write for FREE Instructions. Send Drawing or Model for Examination. Carl Miller, Registered Patent Attorney (former Patent Office examiner), 257 McGill Building, Washington, D. C.

"INVENTOR'S GUIDE," valuable information, free: Frank Ledermann, Registered Attorney-Engineer, 1714 Woolworth Building, New York.

PATENTS. As one of the oldest patent firms in America we give inventors, at lowest consistent charge, a service noted for results, evidenced by many well-known Patents of extraordinary value. Book, Patent-Sense, free. Lacey & Lacey, 648 F. St., Washington, D. C. Estab. 1869.

INVENTOR'S Adviser with mechanical movements sent free. Labiner, 3 Parkrow, New York.

FREE, "Patent Particulars" explaining Terms, Discounts and "Patent Applied For." Sterling Buck, Permanent Building, Washington, D.C.

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Patents for Sale

INVENTIONS Commercialized. Patented or unpatented. Write Adam Fisher Mfg. Co., 183 Enright, St. Louis, Mo.

Photography Instructions

MAKE money in Photography. Learn quickly at home. Spare or full time. New Plan. Nothing like it. Experience unnecessary. American School of Photography, Dept. 1744, 3601 Michigan Avenue, Chicago.

HAVE you a camera? Write for free sample of our big magazine, showing how to make better pictures and earn money. American Photography, 117 Camera House, Boston, 17, Massachusetts.

IMPORTANT to advertisers! Are you deriving profit from your advertising? Write today for a copy of the "Quick-Action Advertising Rate Folder" showing "How You Can Use Popular Science Monthly Profitably." Address your inquiry to: Manager, Classified Advertising, Popular Science Monthly, 244 Fourth Ave., New York.

Photoplays Wanted

$1250 FOR a Photoplay story by an unknown writer and sold through our Sales Department. We revise, copyright and market. Located in the heart of the Motion Picture Industry. We know the demand. Established 1917. Postal brings Free Booklet with full particulars. Universal Scenario Company, 214 Western and Santa Monica Bldg., Hollywood, California.

Printing and Engraving

200 LETTERHEADS and 100 Envelopes, $1.10, postpaid. Oberman Company, Box 1042, Chicago.

Radio

HINTS on buying, installing and operating a radio outfit with list of tested reliable equipment contained in 24-page radio booklet of Popular Science Institute, 248 Fourth Avenue, New York. Price 25 cents.

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Salesmen and Agents Wanted

AGENTS—Clever invention! Inkapoon makes every pen a fountain pen. Fast office seller, big profit, demand increasing everywhere. Exclusive territory offered. Sample free. H. Marul Company, Tribune Bldg., New York.

AGENTS. $60—$200 a week. Genuine gold letters for store windows easily applied. Free samples. Liberal offer to general agents. Metallic Letter Co., 434-A. N. Clark, Chicago.

AGENTS—Best seller; Jem Rubber Repair for tires and tubes; supersedes vulcanization at a saving of over 800 per cent; put it on cold, it vulcanizes itself in two minutes, and is guaranteed to last the life of the tire or tube; sells to every auto owner and accessory dealer. For particulars how to make big money and free sample, address Amazon Rubber Co., 504 Amazon Building, Philadelphia, Pennsylvania.

A BUSINESS of your own—Making Sparkling Glass Name and Number Plates, Checkerboards, Signs. Big Book and Sample free. E. Palmer, 513, Wooster, Ohio.

CALIFORNIA perfumed beads selling like hot cakes. Agents coining money. Big profits. Catalog free. Mission Factory, R 2328 W. Pico, Los Angeles, Calif.

"Don't spoil the party!"

.. someone called when I sat down at the piano

a moment later they got the surprise of their lives!

I WAS just about to enter the room when the sound of my name caught my attention.

"It'll seem like old times to have Dan with us again!" Bill was saying about me.

"Maybe it'll seem too much like old times!" came the laughing rejoinder. "You'd better lock the piano!"

"Nonsense! He won't have the nerve to play after what happened the last time!"

"That was a shabby trick. I almost wish we hadn't pulled it . . ."

How well I knew what they were talking about! Yes, it *was* a shabby trick they had played on me. But, looking back, I really couldn't blame them.

Let me tell you about that last party. Jolly, informal—all the guests old friends of mine. I had sat down at the piano and in my usual "chopstick" fashion started playing some popular numbers.

But before I had played more than two or three pieces I noticed an unusual stillness. I stopped playing, turned around, and saw—*the room was empty!*

Instead of entertaining the party, as I had fondly imagined, my halting, stumbling performance had been a nuisance.

Burning with shame and indignation I determined to have nothing more to do with the "friends" who had let me make a fool of myself—when suddenly it occurred to me that there was a way in which I could turn the tables.

Carefully avoiding the "crowd's" parties, I had bided my time until I was absolutely certain that I could put my plan over. At last, tonight, the moment had come.

Calmly walking into the room I pretended not to notice the guilty expression on Bill's face as he welcomed me. Every one seemed overjoyed to see me again—obviously glad that I had evidently forgiven and forgotten last year's trick.

Suddenly I turned to Bill and said, "Hope you've had the piano tuned, o'd boy. I feel just in the mood . . ."

Instantly the friendly atmosphere changed. It was amusing to see the look that spread from face to face. For a moment no one spoke. Then, just as I was sitting down at the piano, some one called:

"For heaven's sake, get away from that piano! *Don't spoil the party!*"

That was my cue. Instead of replying I struck the first bars of "Sundown." And how! Easily, smoothly, with all the verve and expression I had always longed for!

Gone was the halting, nerve-racking hesitation that had formerly made my playing a torture to the listeners. No wonder the guests gasped with amazement. Fascinated, scarcely believing their ears they drew nearer. When I finished they loudly clamored for more. Time and again, when I would have stopped, they eagerly insisted on "Just one more, please!"

How I taught myself to play *without a teacher*

When they finally allowed me to leave the piano I turned around and said:

"Just a moment, folks! I want to thank you for what you did for me last year!"

The eager, laughing faces turned red with embarrassment. One or two of the boys murmured an apology. Seeing their confusion, I continued:

"I mean it! If you hadn't opened my eyes, I'd still be a dub at playing. I went home mighty angry that night, I'll admit. But it taught me a lesson. And believe me, folks, when I think of the real pleasure I get out of playing now, I'm only sorry you didn't pull that trick sooner!"

Before letting me go home that night Bill cornered me and said, "Listen, Dan, I want an explanation! *How did you do it?*"

I laughed. "Why, I just took advantage of a new way to learn music, that's all!"

"What do you mean 'new way'? Didn't you take lessons from a teacher?"

"No! *I taught myself!*"

"What!"

"Absolutely! You've heard of the U. S. School of Music, haven't you?"

"That's a correspondence school, isn't it?"

"Yes, when that trick showed me up last year, I sent for one of their free demonstration lessons. Well, it proved to be so much easier than I had hoped for, that I sent for the complete course. And believe me, I'm mighty glad I did! There wasn't any expensive private teacher to pay—and since the lessons came by mail, I didn't have to set aside valuable hours to study. I practiced only in my spare time, a few minutes a day. And the course is thorough! Why, almost before I knew it, I could play *anything*—ballads, rhapsodies, waltzes, jazz!"

Which Instrument Do You Want to Play?

Piano	Hawaiian Guitar
Organ	Drums and Traps
Violin	Mandolin
Piccolo	Sight Singing
Clarinet	Ukulele
Flute	Trombone
Harp	Cornet
'Cello	Saxophone

Guitar
Voice and Speech Culture
Automatic Finger Control
Piano Accordion
Banjo (Plectrum, 5-String or Tenor)

You needn't know a thing about music to take this pleasant, rapid course

This story is typical. The amazing success of the men and women who take the U. S. School of Music course is largely due to a newly perfected method that makes reading and playing music as simple as A—B—C.

Even if you don't know one note from another now, you can easily grasp each clear, inspiring lesson of this surprising course. You simply can't go wrong. First, you are *told* how a thing is done, then a picture *shows* you how, then you do it yourself and *hear* it.

Thus you actually teach yourself to become an accomplished musician right in your own home. Without any long hours of tedious practice. Without any dull or uninteresting scales you learn how to play real music from real notes.

Free Book and Demonstration Lesson

Our wonderful illustrated Free Book and our Free Demonstration Lesson explain all about this remarkable method. They prove just how anyone can learn to play his favorite instrument by *note*, in almost no time and for just a fraction of what old slow methods cost.

Remember—it is not too late to become a capable musician. If you are in earnest about wanting to play your favorite instrument—if you really want to gain new happiness and increase your popularity—send off this coupon at once. Forget the old-fashioned idea that "talent" means everything. Read the list of instruments to the left, decide which you want to play, and the U. S. School of Music will do the rest. *At the average cost of only a few pennies a day!* Act NOW. Clip and mail this coupon today, and the fascinating Free Book and Free Demonstration Lesson will be sent to you at once. No obligation. U. S. School of Music, 81 Brunswick Bldg., New York City.

U. S. School of Music,
81 Brunswick Bldg., New York City

Please send me your free book, "Music Lessons in Your Own Home" with introduction by Dr. Frank Crane, Free Demonstration Lesson and particulars of your easy payment plan. I am interested in the following course:

.....

Have you above instrument?.....

Name..... .....
(Please Write Plainly)

Address.....

City.....State.....

Salesmen and Agents Wanted

SUCCEED With Your Own Products. Make them yourself. Formulas, Processes, Trade-Secrets. All lines. Catalog, circulars free. C. Thaxly Co., Washington, D. C.

BIG money and fast sales. Every owner buys gold initials for his auto. You charge $1.50; make $1.35. Ten orders daily easy. Write for particulars and free samples. American Monogram Co., Dept. 47, East Orange, New Jersey.

$50.00 WEEKLY easy, applying gold Initials on Automobiles. No experience needed, $1.45 profit every $1.50 job. Free Samples. "Raico Monograms," 1041 Washington, Boston, Mass.

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DON'T sell for others. Employ agents yourself. Make your own products. Toilet Articles, Household Specialties, etc. 500% profit. Valuable booklet free. National Scientific Laboratories, 1970W Broad, Richmond, Va.

$10 DAILY silvering mirrors, plating and refinishing lamps, reflectors, autos, beds, chandeliers by new method. Outfits furnished. Write Gunmetal Co., Ave. F, Decatur, Illinois.

BIG bunch mail. Year 15c. Catalogues, magazines, Kentucky Agency, Covington, Kentucky.

$12.00 DAILY Showing New Linen-Like Tablecloth. Wash like oilcloth. No laundering. Sample free. Bestever, 118 Irving Park Station, Chicago.

LOID-LAC Amazing New Auto Refinishing Discovery. Not a Paint, Polish, Cleaner or Wax. Restores Colors and Finish to Old Cars in thirty minutes! Greatest Automotive Development in years. Make it yourself with my simple, Guaranteed Formula. Today's Fastest Money-maker. Write or wire for detailed exclusive offer. $50,000.00 Business for $50. Grasp today's opportunity today! Loid Miller, Industrial Chemist, Tampa, Florida.

NO COMPETITION; new electric hot dog machine; sells $18.50; commission $6.50; ready buyers everywhere. Leonard E. Dickerson, Dept. R-2, Springfield, Mo.

MAKE $50.00 daily. 400% profit. Money-getter. Business, professional men buy instantly. Newly patented method for collecting bad debts. Sells $5.00—costs $1.00. Brooks, Texas, sold 20 first day, profit $80.00. Experience unnecessary. Send $1.00 today for $5.00 complete outfit. Territorial rights. Box 596, Hartford, Conn.

$50 to $100 weekly. Men wanted to demonstrate the "fastest selling automobile accessory in the world"—BRITE-LITE—the electro magnetic safety and emergency lamp. It's also a perpetual flashlight. No batteries to buy. It sells itself on sight. County rights now being allotted to live salesmen. Write for demonstrator and sales information to National Electric Corporation, 230 High Street, Newark, N. J.

WALKER made $165.00 first day selling Collection Systems to Doctors and Merchants. Costs $2.50. Retails $7.50. Write Adjustment Association, Mobile, Ala.

ARE You Old at Forty? See Our Advertisement on page 125 of this issue. The Electro Thermal Company, 4013 Morris Ave., Steubenville, Ohio.

YOU Are Wanted to Resilver Mirrors at Home. Immense profits plating autoparts, tableware, etc. Write for information. SPRINKLE, Plater, 96, Marion, Ind.

JUST Out—New Patented Apron. No strings or straps—$20.00 a day every day; over 100% profit; commissions daily. Write for free offer. Sta-Put Co., Dept. 901, St. Louis, Mo.

AGENTS—90c an hour to advertise our goods and distribute Free samples to consumers. Write quick for territory and particulars. American Products Co., 2516 Monmouth, Cincinnati, Ohio.

$100 WEEKLY Easily earned selling new patented electric water heater. It sells for $6.50 and you pay us $3.00. Write to Jiffy Electric Water Heater Co., 842 Maxlow, Royal Oak, Mich.

MAKE $12 a day and liberal bonus selling Pioneer $23.50 and $33.50 all-wool tailoring. Commissions paid daily. 100 extra large cloth samples furnished. We train the inexperienced. Write Pioneer Tailoring Co., Congress and Throop, Dept. A-1121, Chicago.

BIG money permanently selling finest boots and shoes. Call on factories, dairies, etc. Sell 10, 20, 50 pairs one crack. Cash on spot. We show you how. Our plan wins. Agents everywhere cleaning up big. Write particulars, General Equipment Co., Dept. M, Denver, Colo.

SALESMEN—You make $130 monthly selling only one $10.00 Accident, Sickness Policy a day! Policy pays $10,000 death, $25 weekly benefit. Full or spare time. Tremendous demand. $100,000 guarantee with state. Leads furnished from our direct newspaper advertising campaign. Write quick for territory and special contract. Underwriters. 170 Bonnell Bldg., Newark, N. J.

PUNCHBOARD Men! Sideline Salesmen! Sensational Merchandise Catalog just added to famous "Lincoln Line"! No more closed territory! $200 Weekly Easy. Repeat Commissions Paid Daily. Smashing. Color Catalog Free. Samples unnecessary. Best Season Now! Get Busy! Lincoln Sales, 9 So. Clinton, Chicago, Dept. G.

GET our Free Sample Case—Toilet Articles, Flavorings and Specialties. Wonderfully profitable. LaDerma Co., Dept. F, St. Louis, Mo.

$50.00 WEEKLY. Men wanted to demonstrate and take orders daily direct from motorists. Amazing Magnetic Trouble Light. Sticks anywhere! More orders, bigger pay. Write for demonstrator and particulars. The Magno Co., 6 Beacon St., Dept. 461, Boston, Mass.

THIRTY large split pants pattern samples; silk labels. Strong commercial traveler's case. 16 to 20 ounce woolens. No second choices. No substitutions. Tailored from individual patterns. Commissions $8.25 to $18.00! Strictly high class line. Experienced tailoring salesmen apply in own handwriting. References required. Hansen & Clavier, Inc., Great Falls, Montana.

$3.90 PER HOUR Selling a service to keep stairways clean. Every housewife interested. Write today. Ideal Stairway Equipment Co., Dept. PS, Canton, Ohio.

STRANGE Invention! Pays $25 Daily. Keeps telephone and iron cords from tangling and kinking. Prevents iron scorching. Saves electricity. Samples free. Neverknot, Dept. 13-F, 4503 Ravenswood, Chicago.

BIG Pay every day showing Nimrod's all-year sellers Dress, work and flannel shirts, Overalls, Pants, Sweaters, Underwear, Pajamas, Leather Coats, Lumberjacks, Playsuits, etc. Experience unnecessary. Big outfit free. Nimrod Co., Dept. 25, 4922-28 Lincoln Ave., Chicago.

Salesmen and Agents Wanted

43 MILES on 1 Gallon—Amazing Gas Saver. All autos. 1 free. Critchlow, B3-120, Wheaton, Ill.

"GOLD LEAF" Window Letters and Script Signs; no experience; 500% profit; Samples free. Our letters made Hazelhurst $200. week. Consolidated, 69-Y, West Van Buren, Chicago."

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Song Writers

SONG Writers: Let's see what you have to offer! Escher, Music Publisher, 1547 Broadway, New York City.

SONG, poem or melody writers. Have "real" proposition. Hibbeler, D10, 2104 N. Keystone, Chicago.

SONG Poems Wanted: Write at once. Valuable instruction book given free! Bell, Music Co., D-2, St. Louis, Mo.

Sporting Goods

POCKET Gun, 40c! Kills game! Literature for stamp. Grant Mfg., 31st Office, Detroit, Mich.

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Stamps and Coins

STAMPS, 100. All different, 3 cents. Lists free. P. S. Quaker Stamp Co., Toledo, Ohio.

20 VARIETIES unused free. Postage 2c. P. S. Miami Stamp Co., Toledo, O.

FINEST One Cent Approvals in the United States. Stanton (144), Niantic, Conn.

STAMPS, 105 China, etc., 2c. Album (500 illustrations) 3c. Bullard, Station BB, Boston.

RARE United States and foreign coins, war medals and decorations. German bill and catalogue, 10c. Alexis Mengelle, Colorado Springs, Colorado.

CALIFORNIA gold, quarter size; 27c, $½ size; 53c. White cent and Catalogue, 10c. Norman Shults, Salt Lake, Utah.

OLD Coins, large Fall selling catalog of coins for sale free to collectors only. Catalog quoting prices paid for coins, ten cents. William Hesslein, 101B Tremont St., Boston, Mass.

ALL Advertisers should not be without the important facts on Money Making. Write today for the "Quick-Action Advertising Rate Folder" which contains information of value to you. If you are anxious for quick profit returns, do it now! Address your inquiry to: Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

200-200-200. SEND for our 200 outfit containing 200 stamps; 200 hinges; approval sheets to hold 200 stamps; perforation gauge; millimeter scale and ruler; duplicate stamp container—all for only 15c to approval applicants. Edgewood Stamp Co., Dept. S, Milford, Conn.

BIG bargains, ¼c up. Babcock, 409 E. Fort, Detroit, Michigan.

600 DIFFERENT $.50, 1100, $1.00, 2000, $3.50. Fred Onken, 630—79th Street, Brooklyn.

FREE Sets and Packets: Learn about our profit sharing plan. Send for Price List of 1,000 sets; packets too. Send 5c (coin) mailing cost, which we refund with your first order. Attractive stamp given all answering. Argonaut Stamp Co., Dept. 95, New Canaan, Conn.

STAMP Album Free: spaces for 1200 stamps, with purchase of 100 different unused stamps for 25 cents. E. Nagle, 1101 Marion, Reading, Pa.

Stories Wanted

BIG demand for Photoplay and Magazine Stories. We revise, develop and copyright. Sell on commission. Established 1917. Booklet free. Universal Scenario Company, 414 Western & Santa Monica Building, Hollywood, California.

Telegraphy

TELEGRAPHY—Both Morse and Wireless—taught thoroughly, quickly. Big salaries. Wonderful opportunities. Expenses low; chance to earn part. School established fifty years. Catalog free. Dodge's Institute, Hart Ave., Valparaiso, Ind.

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Typewriters and Supplies

TYPEWRITERS—Factory Rebuilt Royals, Remingtons, Underwoods. New Royal, Remington and Corona Portables. New "Excellograph" Rotary Stencil Duplicator $37.50. Terms. Catalogue Free. Pittsburgh Typewriter Supply, 543—339 Fifth Ave., Pittsburgh, Pa.

Wanted

WANTED—Live foreman or mechanic or clerk in every factory in the United States to act as subscription representative for the most popular magazine in the world. Address Manager of Representatives, Popular Science Monthly, 250 Fourth Ave., New York.

WANTED—District Purchasing Agents. No experience or money required. Write Purchasing Manager, 5336 Berenice Ave., Chicago.

MOVIES

Make it Easier to Learn

ELECTRICITY

New Instruction Method *Fits You for* Big Pay *Quickly*

THIS is a ***new, amazingly simple and practical way*** of learning to do electrical work. It is so sure of results that we agree to give you the training and employment service that will get you a better job and more money or ***you need not pay a cent!***

Think of it! You take no chance. We not only train you, we help you get the job. How can we do it? ***By a wonderful new method of teaching which makes everything about electricity easy to understand.***

Learn at Home in Spare Time

We furnish you with the projector, so simple anyone can operate it, and thousands of feet of film. You see all types of electrical machinery in operation, animated diagrams which make the facts about electricity as plain, easy to grasp and as enjoyable as looking at a movie in your favorite theater. It is live, fascinating instruction; no dry text-book study drudging.

Here's what a practical electrical engineer says: "I am amazed at how simply you explain the facts about electricity. The points are so much easier to grasp than by the usual methods of instruction that the student must make quicker, surer progress. I only wish I had had the advantage of your instruction methods. It would have made things so much easier!" Charles E. Fitz, M.E., E. E., formerly associated with Steinmetz.

Film-Way Trained Men in Demand

Our employment service helps you locate a big pay job in the branch of electricity which interests you most: Aviation Electricity, Radio, Switchboard Work, Sub-Station and Power Plant Operation, Automotive Electricity, Wiring, Contracting, Merchandising, etc. Here is an extract from a letter written by an employer:

"We will gladly co-operate with you, not only in employing any of your students when vacancies occur in our organizations, but also by recommending that our employees take your course."

ELECTRIC MATERIAL CO., South Bend, Ind.

FREE OUR NEW BOOK, "The Film Way to Bigger Pay in Electricity"

If you act now, by mailing the coupon, we will send you absolutely free and without obligation, our new book describing the wonderful opportunities for a better job in electricity and giving complete details of this fascinating, new way to learn. Start now to move into the bigger pay class. Sending coupon is the first step. Do it now, learn how to get the things you want in life.

You Use This Real DeVry Projector

Anyone can operate this standard school model DeVry projector (value $75) which is furnished every student for use during course ***at no extra cost.*** Uses ordinary light connection, farm lighting equipment or auto battery. Gives clear, brilliant, flickerless motion pictures in your home.

Drafting Set Given

Course includes instruction in drafting and complete set of professional instruments as shown, with drawing board, T-square, scales, rules, paper, etc., all given at no extra cost. You get everything necessary for this complete course in electricity with drafting.

The NATIONAL SCHOOL of VISUAL EDUCATION

"The Film Way to Bigger Pay"

537 South Dearborn St., Dept. F-1 CHICAGO, ILL., U. S. A.

Without obligation to me please send your book, "THE FILM WAY TO BIGGER PAY IN ELECTRICITY"

Name..... Age.....

St. or R.F.D.....

City.....

State.....

County.....

TAKE THE FILM WAY TO *Bigger Pay*

What the World Owes to 1928

(*Continued from page 29*)

henceforth certain body colors, lines, and trimmings will have their vogue.

More interesting to the technical mind have been the efforts toward greater comfort and convenience for driver and passengers. Easier riding has become a scientific study. Instruments are replacing human judgment in measuring riding qualities, helping to better correlate springs, shock absorbers, weight distribution, seat cushions, tire sizes, and pressures, to allow faster comfortable riding and longer driving without fatigue. Vibrationless power transmission is being sought, and we find more use of rubber insulators in engine and other mountings, better engine counterbalance, vibration dampeners, lighter reciprocating parts, quieter gearing. We have easier gear shifting, simplified chassis lubrication, quicker pickup through more power, and less tiring steering and braking mechanisms.

PSYCHOLOGY

A. D. POFFENBERGER, PH.D.
Department of Psychology, Columbia University

PSYCHOLOGY today has shifted emphasis from intelligence to emotion as a motivating force in human life. Further, the emotional makeup as an inherited and fixed possession of the individual has given place to a more plastic natural status upon which beneficial emotional impulses may be developed and harmful ones avoided. Heavier responsibility thereby falls upon those who guide the child through its earliest years when its motivating forces are in the making.

Hand in hand with this interest in emotional life there goes the attempt to measure it and evaluate it as an ingredient in success. Tests of temperament, character, and emotional stability are as numerous as tests of intelligence.

A specific achievement of great importance is the discovery that adults, unlike old dogs, can learn new tricks. It has been demonstrated that adults can learn such things as they need to learn almost as readily as the child or youth.

METEOROLOGY

CHARLES F. MARVIN, M.E.
Chief, U. S. Weather Bureau

AN IMPORTANT meeting of European and American meteorologists was held at the Paris office of the French Meteorological service during the third week of May, 1928. The purpose was the better international organization of weather observations and reports from ships at sea, especially those plying the North Atlantic Ocean. Plans contemplate the extension of the work to all oceans as far and as soon as practicable.

This program of extension is the great forward outlook and step of the present time. It has been the dream of meteorologists for fully fifty years. The advanced stage of development of communication over the oceans by radio makes fulfillment of the hope possible and gives promise of its early realization.

As the organization is developed, each nation is responsible for securing at least two, and if possible four, observations and radio reports each day from certain selected ships of its own registry. The weather conditions over the oceans will then become as well known as those over the land. The information is of vital importance to the safety of life at sea and to aircraft flying over the oceans. Several huge passenger-carrying airships are now nearing completion and the meteorologists of the great maratime nations are eagerly coöperating to supply transoceanic aircraft of all kinds the best possible weather service.

MEDICINE

MORRIS FISHBEIN, M.D.
Editor, Journal American Medical Association and Hygeia, the Health Magazine

VITAMINS continued to engage medical attention during 1928, increased interest attaching particularly to the possibility of vitamin B deficiency in the American diet, and to the relationships of the new vitamin E, especially to sterility. The possibilities of dangerous results from too much vitamin and from vitamin imbalance received extended consideration.

Ultra-violet transmitting glasses lost popularity through establishment of the fact that in most large cities an insufficient amount of ultra-violet penetrates through from the sun. American women reacted favorably to public health education and the craze for weight reduction began to disappear.

It was found possible to transmit yellow fever to a certain form of African monkey, thus making it no longer necessary to carry on dangerous human experiments. Investigators in the University of Wisconsin

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"How I Laughed Myself Into Success in Radio"

by Howard Clark

"I'm sitting on top of the world! My bank account is growing fatter every day . . . my home is all paid for . . . I've just ordered a new car . . . and my wife and I can at last enjoy life in real style. It sure feels great to be earning big money. And to think how it all came about!"

• • •

IT happened on a rainy Monday night. I was reading a magazine while Mary was clearing away the supper dishes. Suddenly a funny cartoon caught my eye . . . and I laughed out loud.

"Jim, you make me sick!" she cried. "How can you laugh while I'm nearly dying of weariness!"

"But Mary dear—"

"Don't dear me, you idiot!"

I was alarmed. "Great heavens, what's wrong?"

"Wrong?" she screamed, "here I drudge all day, do my own housework, wash all the clothes, take care of the baby, and worry about your meals. I never get a moment of freedom . . . and haven't a decent thing to wear even to church . . . yet you never seem to care!"

I was ashamed!

A feeling of shame swept over me. So that was why she seemed so "moody" the last few days! Like a good sport she had suffered in silence until she couldn't keep it in any longer. Poor kid!

For hours after Mary had gone to bed that night I kept staring into space. What a mess I had made of our lives . . . What a slave I had made of her.

Listlessly I kept thumbing the pages of the magazine . . . thinking . . . thinking. Was there no way out of it?

Then suddenly . . . as if by some kind act of Providence . . . . I stopped before a story. It told of a fellow who had made quite a fortune in an uncrowded profession. Fascinated, I read on. It told of the brilliant opportunities in the radio industry . . . of the big incomes fellows like myself were earning . . . and of the ease with which expert radio training could be acquired. But what impressed me most was the

fact that success was practically assured by means of a new home-study laboratory method sponsored by three of America's great corporations.

With gigantic enterprises like these behind a school I needed no greater guarantee . . . . so without a second's further hesitation I tore the coupon and mailed it.

A lucky event that changed my life

It sure was my lucky day, when the first lessons came in. I never dreamed that learning radio was so easy. I didn't know the first thing about it when I started. Yet before many months were over I was able to solve many of the problems which command big pay.

Each subject was explained in simple word and picture form. It carried me along like a novel. From magnetism and electricity the lessons took me step by step through trouble-finding and repairing—through ship and shore and broadcasting apparatus operation and construction—through photoradiograms, television and beam transmission.

I didn't have to give up my regular job. I stayed right at home and learned during my spare time. I actually learned by doing. With the lessons I received a complete, expensive storehouse of apparatus with which I was able to build radio circuits and sets of almost every description. Yet it cost me absolutely nothing extra.

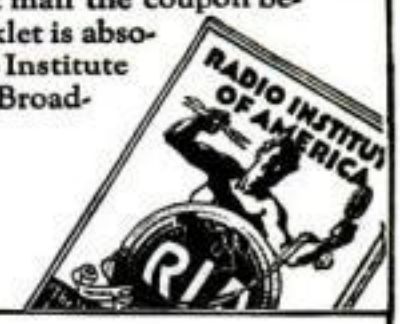
As a result of this practical, technical working out of big radio problems with a fine home-laboratory, I was able to earn good money even before I had completed my course! And it wasn't long before I was able to quit my regular work entirely . . . and branch out for myself in big paying radio jobs.

Today, I have more work than I can take care of. And I often make more money in a day than I used to earn in a week.

Read this thrilling Free Book

Howard Clark's story is typical of the success which scores of other men have achieved . . . through the "big-league" training given by the home-study course of the Radio Institute of America ... the only school in America sponsored by RCA, General Electric and Westinghouse.

Radio needs you. Manufacturers, dealers, broadcasting stations, ships . . . all need trained radio experts. The pay is big. The opportunities are limitless . . . The work is thrilling! Find out all about it. The Institute has prepared an interesting, illustrated booklet telling you all you want to know about this vast industry and about the remarkable home-study course that can fit you for a brilliant radio career. Just mail the coupon below . . . the booklet is absolutely free. Radio Institute of America, 326 Broadway, New York.



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Gentlemen: Please send me your big FREE 50-page book which tells about the great opportunities in Radio and about your famous laboratory-method of radio instruction at home.

Name.....

Address.....

What the World Owes to 1928

(*Continued from page 138*)

discovered that copper is a substance of greatest importance in relationship to the formation of the blood in the human body. Heretofore it has been the general belief that iron was the chief mineral salt of importance in this connection.

Work on the blood indicates the possibility of determining eventually parentage and heredity by blood examinations. Surgery finds it possible to remove one half the human brain with recovery of the patient. The cause of measles is not yet determined; but investigators approach it closely. When the cause is fixed, a skin test and serum for prevention will be possibilities.

PHYSICS

G. K. Burgess, D.Sc.
Director, U. S. Bureau of Standards

THIBAUD, Hunt, Osborne, and Hoag, working independently with gratings, have together succeeded in bridging for the first time the gap in the spectrum between X-rays and the ultra-violet region. X-rays now form a branch of optics.

Franck, Birge, and Miss Sponer have shown that the heats of dissociation of chemical compounds can be determined from spectroscopic measurements.

Raman and Krishnan have found that when liquids are illuminated with monochromatic light, the scattered light contains not only the original line but other emission lines of both shorter and longer wave lengths. This lends further support to the conception that the liquid molecule contains electronic systems vibrating with definite frequencies, upon which the impinging monochromatic light reacts to set up new wave lengths. According to the new wave-mechanics, electrons are nothing but wave systems. Sir J. J. Thomson points out, however, that if an electron is regarded as an assemblage of lines of force, starting at the charge, it has definite frequencies and can absorb and transmit electric waves even when the center remains stationary.

EXPLORATION

Gilbert Grosvenor, LL.D., Litt.D.
President, National Geographic Society

ADVANCES in geography and exploration were more than usually marked by steady progress all along the line. The ill-fated Nobile airship voyage to the North Pole was the tragedy of the year, although taken with the successful Wilkins-Eielson flight from Alaska to Spitzbergen, it

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What the World Owes to 1928

(Continued from page 140)

helped to disprove the idea of the existence of a great land mass in the hitherto uninvaded regions of the Arctic.

There were scores of expeditions in the little-explored sections of China, in the interior of Africa, and in the inner Amazonian empire. Advance reports indicate that they have brought back a wealth of information about little-known areas. Among these expeditions was that of the National Geographic Society to the Pavlof Island volcanos off the Alaskan peninsula, headed by Dr. Thomas A. Jaggar.

The sea also was made to contribute to the growing fund of knowledge. The perfection of gravitation-measuring instruments made possible new determinations of the weight and shape of the earth. The American and Dutch navies contributed the use of submarines in these undertakings. Sonic depth finders were employed in every ocean to trace out the terrain of the sea floor.

The year also was marked by the departure of Commander Byrd and Capt. Sir George H. Wilkins for the Antarctic to lay siege to the secrets of the Antarctic from opposite sides of the continent.

ANTHROPOLOGY

ALES HRDLIČKA, M.D.
Curator, Division of Physical Anthropology, U. S. National Museum

THE main advances in anthropology during 1928 were in the field of prehistory of the Old World. Further excavations by Absolon in the vast Aurignacian-station of Vieston ice, Moravia, brought the number of specimens recovered to over 300,000, and culminated in the find of a human skeleton with a remarkable necklace of Arctic fox teeth. Weidenreich published the first account of the highly interesting new Ehringsdorf skull. Miss Garrod, Buxton, and Elliot Smith reported on the new Mousterian find, including a child's skull, of Gibraltar. And Hrdlička in his Huxley lecture showed that in the light of present evidence science is no more justified in excluding the Neanderthal man from our ancestry. A valuable find of later prehistoric skeletal remains was brought from British East Africa by Leakey.

In America archeological work was carried on in Yucatan, Guatemala, Honduras, and the southwest, by Carnegie, English, Smithsonian and other workers.

The Real Fathers of Flight

(Continued from page 19)

Peter Pan and Orville Wright are related to each other! The latter is perhaps shyer and more sensitive than his fictional counterpart. At the same time he has iron in his soul, an endless tenacity of purpose within a frail body and a delicate nervous system. He is full of gentle humor. Hawthorne and Gelett Burgess are his favorite authors. He likes *The House of Seven Gables* and equally *The Purple Cow*. He used to chuckle with delight over the absurdities of weird inventions as depicted by Rube Goldberg, the cartoonist.

The child is indeed father to the man, emphatically so in the case of the Wright brothers. Their boyhood illumines and makes credible their amazing achievement as men. It is evidential and vital to the history of the airplane. So I am going to tell every least boyhood tale and anecdote along with other matter supplied to me by Orville, Katharine, and their father, who is now dead.

THE family is of mixed stock—English, Holland, and German-Swiss. The earliest ancestor, Samuel Wright, deacon and lay preacher, left Essex, England, to come to this country, and he settled at Springfield, Mass., in 1636. His great-great-grandson, Dan, moved in 1814 to Centerville, Ohio, now a suburb of Dayton but then a frontier point almost in peril of lurking Indians. Here the son and namesake of Dan, grandfather to the pioneers of the air, married in 1818 Catharine Reeder, whose father had been killed by redskins. Her mother, Margaret, had been the first white woman in Dayton, which was partly founded by a brother, Benjamin Van Cleve, after whom one of the present city hotels is named.

Milton Wright, father of the inventors, was born Nov. 17, 1828, in a log cabin on a farm in Rush County, Indiana. The cabin was "pretty well scutched," having the outside of the logs neatly smoothed with the broad ax. It had a fine living room that served also for bedroom, kitchen, bath, and what you will. In short, a one-room cabin with a good fireplace. Tallow candles and pitchpine knots. The farm equipment consisted of one ox and a wooden plow with iron shod point.

MILTON was converted at eighteen and joined the United Brethren Church, a sect which derived from the Lutherans, prospered among the German-Americans of the Middle West, and once had about 300,000 adherents. He studied for the ministry at a little college called Hartsville in a town of the same name in Indiana. A fellow student became his wife and the mother of the inventors. She was Susan Catharine Koerner, of German-Swiss extraction, and was born in Hillsboro, Virginia, April 30, 1831. Her father was John Gottlieb Koerner, a wagon maker, born near Schleitz, Germany, who fled to this country from military conscription of the Napoleonic era. Her mother was Catharine Fry, an American of German-Swiss descent.

Perhaps the student of heredity can draw some conclusions from the mixture of racial strains, dogged, substantial, and alert.

Father Koerner had a shop in which he built farm wagons and carriages. It contained a turning lathe operated by foot power, probably the first machine ever seen by two little boys who were awed by it and did not dream they would become considerable mechanics themselves.

Orville Wright well recalls Grandpa Koerner who took him, a little tad, between his knees. We can imagine the grizzled old man muttering:

"Ja, ja, I could make you a good wagon-builder, yes!"

The parents of the inventors moved around after their marriage, the husband combining school teaching with farming and circuit riding. They stayed two years on a farm near Fairmount, Indiana, which was enlarged to some size in time and remained a family property. The house was a log cabin of three rooms. The first child was born here on March 17, 1861. He was named Reuchlin, after a German theologian. The father picked out the names of all his sons and worked on the theory that Wright, being common, needed an unusual handle.

Milton became a presiding elder of the United Brethren and on the death of his father took his family to spend a winter with his mother in Fayette County, Indiana, where the second child, Lorin, was born Nov. 18, 1862. The name of Lorin was picked offhand from a map; it just looked good. There was a removal to Dublin, Indiana, for a couple of years, and thence to Millville in the same state for a stay of three years.

SOMETHING important happened at Millville, or, more exactly, two and a half miles northeast of that hamlet, within a frame house of five rooms. Wilbur Wright was born here on April 16, 1867. The co-inventor of the airplane was named after Wilbur Fiske, a personage in the Methodist Episcopal Church.

Again the family moved, this time to Hartsville, where the parents had studied and courted. Now the father was minister of a church and also taught theology in the college. After a year he left to become editor of *The Religious Telescope*, a weekly church organ, at Dayton.

A small house was bought on Hawthorn Street about a mile and a half from the center of Dayton, then a sleepy town instead of the throbbing industrial city of today. This house was the family home for over four decades. Orville Wright was born in this dwelling on August 19, 1871. It was the only home of Wilbur Wright in his manhood and the place where he died. Moreover, within these four walls the airplane was largely conceived and created.

IT WAS a little frame structure with wood shingles on peak roof, wide clapboards painted white, and green shutters at the windows. There was a small porch at the kitchen end. A partial cellar extended under the living room. The new owner raised the back roof so as to have four bedrooms upstairs, matching the number of rooms below. No plumbing and no bath. An open well with a wooden pump at the back door was the water supply. Oil lamps gave light, coal stoves heat, and cooking was done with firewood in the kitchen range. The lot was thirty-seven and a half feet front and 130 feet deep. The house and lot probably had a total value around $1,500.

A few improvements, including some done by the hands of the inventors, were made in after years.

Orville, who arrived here, following twins who died in infancy, owed his name to Orville Dewey, a Unitarian minister. His familiar title became Orv and Orvy. To his brother Wilbur he was latterly Bubbo, even in letters, while his sister Katharine addressed him as Bubs.

The sister and last child—who plays a vital rôle in the historical drama of the airplane—saw daylight on Hawthorn Street on August 19, 1874. It was thought a lucky ecoromy that her birthday coincided with Orville's. Catharine was her name by due inheritance, but the C soon shifted to K through the short form of Kate. A relative bestowed the title of Schwesterchen, or little sister in German, which a childish blunder split into two nicknames, Swes and Sterchens. The latter especially became Katharine's appellation in the home and in letters by

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The Real Fathers of Flight

(Continued from page 142)

her famous brothers. The Rev. Mr. Wright, as church editor, had a salary between $1,000 and $1,500 a year. This was a good income compared with a maximum stipend of $600 in his circuit-riding days. Thanks to his wife's careful housekeeping, it was enough to provide fairly well for the family and also to put by something for the future. There was enough plain food on weekdays and a good dinner on Sundays. Clothes were made over down the line, starting with the retired broadcloth of the minister, so that each child was decently clad.

Mother Wright was "just worshipped" by her children. She had time to play with them while doing all the cooking and housekeeping, making new garments for the minister, and remodeling castoffs for the youngsters, mending, darning, sweeping, washing, even cutting the children's hair with or without a bowl to guide the scissors. At night she listened to the editorials written by her husband for the *Telescope*. He read them aloud to her and took heed of her comment and suggestions for changes. He depended on her to keep his style simple while he availed himself of her fertile and vivid ideas. Doubtless he was influenced by her to become an early advocate of woman suffrage. Long after her passing, Bishop Wright, at eighty-six, marched a mile and a half with his son Orville in a suffrage parade through Dayton.

SPRIGHTLY and keen witted, Susan Wright had an original mind and a knack for invention. She taught herself to design clothes. She made and fixed things around the home. She gave an example to her youngsters in self help, tinkering, and creating. A sled was wanted one winter by the two older boys. There was no money to buy it. So the mother built a sled with her own hands and it was just as good as a store kind. She was apt with tools and clever with her hands—unlike her husband. Perhaps she inherited deftness and the creative spirit from her father, the German woodworker and carriage maker, and passed on these gifts to sons in whom they were intensified to an illustrious degree.

"Have you heard the latest about that boy Orville?" said one gossiping neighbor to another. "Only seven years old and he and another boy have a little wagon and they go around picking up bones and sell them to the fertilizer factory."

"Do tell! I wouldn't let my youngster do it. Why, you know a fertilizer factory smells something awful."

"Of course. It's terrible. I hear he finds out which way the wind is blowing and only delivers when it's *to* the factory."

"Mercy! Only, if the wind changed, he might be afflisticated."

The proceeds of the bone traffic went to candy and fishing tackle. Orville lost one good length of fish line owing to his habit of snaring things on land. He tossed a snare into an alley, roping a pig that galloped off with yards of valued fish line.

Making fires was an early passion. Aided by his pal, Ed Sines, he started a blaze against the back fence of the homestead. Three-year-old Katharine ran and tattled to her mother, who put the fire out. It took a long time for Orville to forgive his sister for tattling and he still likes to make and see fire, the larger the better.

An event which seemed quite trivial at the time but now appears a signpost on the road of destiny happened when Wilbur was eleven and Orville seven years old. The father went away on a church trip. He thought the boys had been pretty good lately and he would buy them a present. "Boughten" gifts were somewhat rare in that frugal home. Yet he liked to bring home a few (Continued on page 144)

The Real Fathers of Flight

(*Continued from page 143*)

cheap knickknacks for the family. An odd toy caught his eye in the city store. It was expensive, a useless plaything at the price of a good shirt, a hymn book, or a pair of copper toed shoes. He hesitated. He examined the foolish doodad, was fascinated, and yielded to the extravagant urge.

UPON a late autumn evening the father walked into the living room of the Hawthorn Street house with an air mysterious, his hands covering some object.

"What is it, father? What is it?"

"Something for you boys." He smiled down at the children.

"Let me see it! Please, father, let me! I said it first!"

"Watch now!"

"O-h-h-h-h!" gasped the awe-stricken youngsters as the father opened his hands and a shiny thing leaped into the air. It rose whirringly and smote the ceiling, fluttered a moment as if undecided on its next course, and then sank slowly to the floor.

"It's a bat!" shrieked the ecstatic lads.

"A flying bat! Isn't it, father?"

"No," we can imagine the response, "it is not alive. It is a machine. You see it has two little fans that whirl around because of the pull of this twisted rubber band. The frame is cork and bamboo and the rest is paper. So it is very light. I guess these fans push against the air just as a ship propeller pushes against water. Perhaps there *is* some likeness between this machine and a bat or bird. Anyhow they both fly. This is a scientific toy. I won't ask you boys to spell its name. It is called a helicopter."

FOR the next few days the flying bat was put through its paces within the house and out in the back yard. It had a strenuous tryout at the hands of two enthusiastic and ruthless experimenters. They were at it morning, noon, and night. They subjected the motive power to a cruel strain. They racked and tore the fragile device with eager fingers, loudly warning each other against violence.

"I declare, those Wright boys are perfect terrors!" remarked a cross-eyed neighbor, discussing the news of Hawthorn Street with her best friend.

"What have they done now?"

"Why, their father bought them an expensive toy. I hear it cost fifty cents. And in no time at all they tore it all to pieces!"

"What a shame. Minister's sons, too."

"That's what I say. I don't see how such destructive little hellions will ever amount to anything! Now my boy——"

Meanwhile Wilbur and Orville Wright had blissful dreams around an experience never to be effaced from memory. That beautiful marvel! That lovely thing that acted like a living creature of the void!

It is a machine. Father said so. The fans go round and round and push the air. They go so fast you can't see them. Faster than a bat's wings. It is a flying bat, like the one that went through the attic window. It might be a bird, the same as those that fly around the chimney.

Oh, if I could fly like that!

Destiny smiled tenderly on the sleeping lads.

IN ANOTHER absorbing chapter next month, Mr. McMahon tells the story of the Wright boys' early experiments in the mechanics of flight, interweaving fascinating anecdotes and dramatic incidents. You won't want to miss a single installment of this remarkable narrative.

Fires Start Themselves

(Continued from page 51)

ing cases of magnesium powder—a photographic flashlight material—decomposed. Streams of hydrogen gas filled the elevator shaft and exploded, killing several men.

Fire experts are beginning to recognize a hitherto unsuspected hazard—what is known to chemists as "catalysis," the ability of certain metals and other substances to promote chemical reactions, including explosions, in seemingly impossible circumstances. For example:

Filing cabinets were being baked in great enameling ovens at a Rochester, N. Y., plant not long ago. Benzol fumes from the enamel solvent filled the ovens, which were kept carefully several hundred degrees below the heat at which the fumes—it was thought—could explode. Yet one morning an attendant opened an oven door, and the resulting blast threw him bodily across the room. Experts who investigated advanced the novel theory that the steel in the oven may have aided the chemical union of benzol vapor and air that produced the explosion.

WHEN you scuff across the carpet, on a clear dry day, you may notice a faint spark fly from your finger tip as you touch a metal fixture. That baby spark of "static electricity," in other circumstances, is the bane of firemen. It can cause anything from a gasoline filling station blaze to a dust explosion that will wreck an entire factory.

Many are the stories told of gasoline tank truck fires from static sparks; most trucks, in fact, drag metal chains along the ground to carry off harmlessly any electricity that may be generated by the swishing liquid within. But the strangest tale is that of a "human dynamo" who by some peculiar condition of his body seemed to be an extraordinarily good electric generator.

This man, a driver for an Arizona oil company, burned up three tank trucks before they caught him at it. Each time the circumstances were the same. His truck carried five-gallon pails which were hung on the cocks at the rear of the truck and delivered, two at a time, to the consumer. By the time the driver returned with two empty pails to substitute for the full ones hanging ready, he had acquired a new electric charge and a spark would leap from his fingers past the inflammable gasoline. Puff—and another tank truck would go up in flames. Finally the man was transferred to another department where his dynamo proclivities could do no harm.

WHEN the Massachusetts State Police, some time ago, investigated a number of automobile fires at filling stations, they found that the mere passage of gasoline through a filling hose generates enough static electricity to ignite the car's tank, under favorable circumstances. Probably you may never see your car catch fire at a gas pump, because these accidents are rarer than they once were; thanks, largely, to the lower inflammability of present-day gasoline. But if the metal filling nozzle is held away from the rim of the tank opening, a dangerous spark *may* jump a half-inch between them as the rushing gasoline piles up an electric charge on the nozzle. It is safer to let the nozzle touch the tank rim constantly during filling.

Amateur dry cleaning is one of the primary fire hazards in the home, due again to static. Swishing silks, furs, or leather in gasoline is an ideal way to generate sparks, which are likely to leap just as the material is withdrawn from the liquid—particularly if the cleaning is done in a pan on a wooden table, which insulates the electricity and prevents it from running off harmlessly to the ground. Any such work is best done, if at all, out of doors, where inflammable vapors usually (Continued on page 146)

Fires Start Themselves

(Continued from page 145)

are quickly dissipated. That even here this is not always so is shown by a case on record of a smoker who ignited vapors from a wrecked gasoline tank more than 150 feet away.

One ironic illustration is that of a woman who, shortly before she was to deliver an address on the hazard of home dry cleaning, washed her arm-length gloves in gasoline. Having donned them to dry them smoothly, she was rubbing out the creases, when a spark ignited the gasoline. She died from burns received before she could strip off the gloves.

Many oil tank fires of mysterious origin are believed to have started by static sparks. A mere twenty-foot drop in an oil pipe may create a dangerous accumulation of static electricity by the time that oil reaches the lower outlet.

EVERY industry, in fact, knows the menace of static. Wherever belts are whirring or cylinders turning, in newspaper, textile, or rubber plants, there is the chance of a spark that will touch off anything inflammable near by. Once the Department of Agriculture investigated a series of strange fires that started in great combination cutting and threshing machines, each time destroying the machine and spreading to the entire field. Static sparks, it found, ignited the wheat or other produce in the machine. Wherever wheat rust, a disease that transformed the wheat into almost pure charcoal, occurred, the trouble was greatest. When threshers were equipped with electric connections to the ground the fires ceased.

Dust seems hardly a likely source of fire; yet, suspended in the air in fine particles, it may be a more powerful explosive then dynamite. Aluminum dust wrecked a Racine, Wis., plant when it was ignited, presumably by static electricity, during its manufacture for use in silver paint. Here the metal, reduced to powder, became highly inflammable. Either static sparks or electric lamp connections may have ignited the pyroxylin lacquer dust, a substance used for paint spraying, that exploded and razed a Detroit, Mich., factory last year. The dust of sulphur, hard rubber, sugar, and cork, to mention only a few, have each caused a number of tragic explosions and fires.

In marked contrast to the lightning-swift consequences of a dust explosion is the slow, smoldering birth of spontaneous combustion. Oil- or chemical-soaked rags are the most familar causes. But, as one incident shows, they are by no means the only ones.

WITHIN a red brick newspaper building in New York City, one night, printers were making ready the presses for editions of the following day when one of them saw smoke seeping through chinks in the board partition separating the plant from a cigar store next door, closed for the night. Entering the store they found shelves lining the wall to within two feet of the ceiling, filled with boxes of cigars—and, atop a shelf, an eight-inch pile of newspapers that exuded a telltale trail of smoke. In a moment the fire in the burning papers was stamped out.

Examination showed that the scorched shelf, a solid one-inch plank, had not been burned through from below. And the papers had been charred, not on top of the pile, but *beneath* and *inside* it. There was but one possible verdict—"spontaneous combustion."

Experts explain that, given three circumstances, spontaneous combustion will surely follow. The first is the real cause—usually, an animal or vegetable oil that will turn rancid. Fish oil, linseed or other "drying oils" used by painters, even salad oil may suffice. Next is the tinder; any inflammable material, such as rags or paper. The last requirement is that these materials be confined so that the heat will not escape, but will con- (Continued on page 147)

A definite program for getting ahead financially will be found on page four of this issue.

Fires Start Themselves

(Continued from page 146)

tinue to raise the temperature of the inflammable mass until it catches fire.

A tight-piled mass of oil-soaked painters' rags fulfills these conditions ideally. Action of the air's oxygen upon the oil starts the trouble. It generates spontaneous or self-produced heat, and the temperature in the confined mass rises slowly to the burning point. Hours may pass before a pillar of smoke and fumes gives warning. So surely will such a combination produce fire that one Eastern insurance firm stages a regular demonstration of spontaneous combustion by placing oily rags in a covered bucket. In three hours the lid is lifted and the rags are seen burning.

As for the fire that started in a newspaper pile, just described, it was explained that printer's ink in the papers—aided, perhaps, by a little sulphur in the paper stock itself—had been the fire-causing agent. So rare is this occurrence that but one other similar case, in a private home, has been reported to the National Board of Fire Underwriters. Even so, it advises against piling newspapers in a tight, unventilated heap.

IN THE flood that swept through Vermont not so long ago, barns were inundated with water. Oddly enough, several strange fires that followed in the flood's wake were traced to the wetting of the hay.

One farmer's hay-filled barn near Middlesex, Vt., caught fire two days after the flood had receded. Heat generated in the wet bottom layers of the hay pile had produced hot drafts to the upper surface, and finally had ignited the close-packed mass.

Shipping dairy feed composed of alfalfa and molasses is a hazardous business, due to spontaneous combustion. Railroad experts are powerless to prevent it, and the only way to avoid burning up freight cars is to rush the stuff to its destination and unpack it at once. Even at that, a car catches fire.

In great coal piles occur some of the most troublesome cases of spontaneous combustion. In one case a discarded Christmas tree left on the coal pile of an Indiana public service company started a coal fire. A board fence started another, and wind-blown autumn leaves a third. Often coal fires start themselves; most coal piles have "hot spots" which, if they once attain a temperature of from 140 to 180 degrees F. are likely to mount rapidly to the burning point unless discovered and the coal spread out to cool.

SO DIFFICULT is a coal pile fire to extinguish that the usual ingenious expedient is to make no attempt to put out the fire—but to load the burning coal on trucks and feed it at once into the factory boilers to save what is left of it for power!

To the present list of queer fires the future may add still others. There are today fires of more or less regular occurrence whose cause is still utter mystery. Within the last few months strange blazes have occurred in Cuba, Indiana, and Louisiana sugar refineries. In each case, investigators found, they started *in the center of bags of granulated sugar*. Since sugar alone has long been on the "innocent" list of substances supposedly incapable of spontaneous combustion, the theory has been advanced—and subsequently denied—that the sugar bags had previously been used for some such combustion-aiding material as saltpeter, and not properly cleaned. The real cause is still unknown.

HOW much do you know about the weather? Turn to page 56 and see how many of the questions you can answer correctly. Similar questions on various phases of knowledge, and their answers, appear each month in POPULAR SCIENCE MONTHLY.

Five-Million-Volt Gun Built to Smash the Atoms

(Continued from page 24)

pose to harness for the atom's destruction Nature's lightning itself!

Upon a mountain crag purposely chosen because of the frequency and violence of local thunderstorms, Doctors A. Brasch, F. Lange, and C. Urban, of Berlin University, have erected the diminutive "lightning-proof" cabin, sheathed with sheet metal. Overhead, across a chasm between the pinnacles of two lofty crags, they have suspended a mighty aerial 2,500 feet long. Its purpose is to trap the air's electricity during violent thunderstorms and harness it to destroy the atom.

Great "corona sheaths," weird-looking cylinders of galvanized iron more than two feet in diameter at some places on the antenna, prevent the currents from leaping in flaming halos from the wire. At the terminals of the cables, also, chains of thirty insulators such as are used singly on high-voltage transmission lines bar a sputtering flash to the mountain itself.

ALREADY, from a small test aerial, the experimenters have drawn sparks fifteen feet long, indicating a potential of more than two million volts. During one thunderstorm such sparks occurred regularly, once every second, for half an hour. Others flashed whenever a lightning bolt passed overhead. Even in clear weather, electricity in the upper air supplied three to five thousand volts.

Now that the 2,500-foot antenna has been installed, the lightning-tamers expect that they will be able to harness current of from five to thirty millions of volts! As some indication of the forces they seek to control, the energy of a single lightning flash lasting but a fraction of a second, from a cloud a mile high, is sufficient, it is estimated, to operate the entire subway system of New York City for a full hour!

With suitable tubes to apply such a force in their sheet-metal laboratory, the German scientists, too, would smash the infinitesimal atom, the building block of which every tangible object you know is made—the wood in your house, the clothes you wear, the very food you eat. Tiny? Magnify a drop of water to the size of the earth—and the atoms within it would be only the size of footballs. That is the elusive target they aim at—and yet, should they demolish it, the resulting upheaval might either wreck the laboratory and the experimenters with it, or confer incalculable boons upon humanity.

PERHAPS limitless stores of energy lie locked with the tiny atom's shell, awaiting only its bursting to pour forth and run the world's machines. More likely, the experimenter who blasts the atom to pieces may be the first practical alchemist. He may be able to turn silver into gold, and lead to iron, at will, simply by pulverizing them in his atomic meat-chopper and fashioning new elements out of the plastic mass.

Of course, this is conjecture. No one knows, surely, what may happen if the atom yields. Above all, it is the love of the unknown that lures experimenters to play with forces greater than any hitherto conceived—forces whose appalling consequences can only be guessed.

So electricity, now, is again selected for the crucial test, but with new hope of success, by these modern delvers into the borderland of science.

A GREAT human drama is unfolded in the real inside story of Orville and Wilbur Wright, beginning in this issue. You can't afford to miss a single installment of this absorbing narrative of how the airplane was born.

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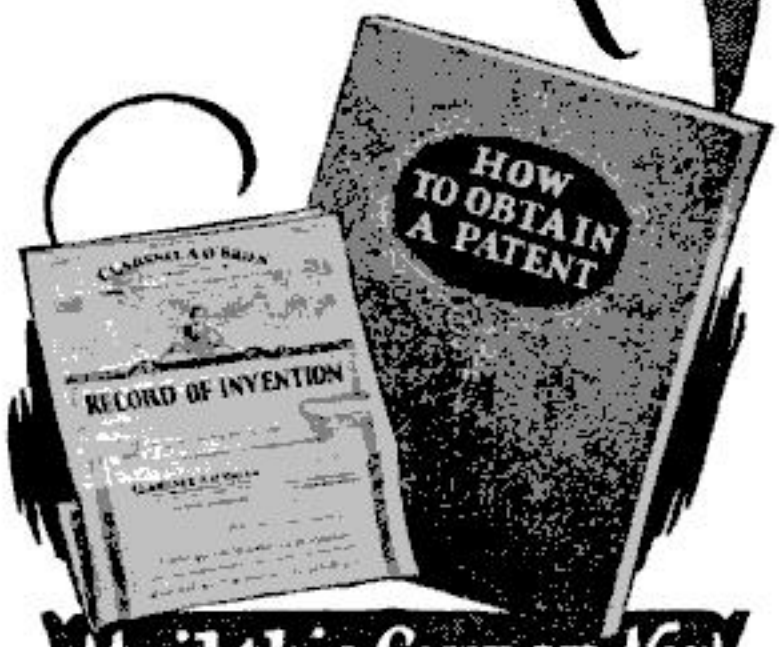

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Wonders of Neon

(*Continued from page 47*)

daylight scene. Moreover, neon light is economical and considerably cheaper in operation than ordinary incandescent lamps giving the same amount of illumination. Less than four percent of electric energy, it is said, is wasted in heat. Compare that with the high-power electric bulb in your home that burns your hand if you touch it while it is lit! Transformers supplied with the signs convert ordinary lighting current into the 8,000 to 10,000-volt current used to operate the cool neon tubes.

Airplane beacons use neon light extensively because orange-red light, such as neon provides, is peculiarly well able to penetrate fog. Stationary installations of great neon-filled tubes atop towers and office buildings guide passing planes; other types of beacons are revolving searchlights with a compact neon light providing the beam. Often neon beacons can be seen for ten or twenty miles through haze when other lights are invisible.

ONE novel type of air beacon recently exhibited uses as its light source a small hollow glass bulb, filled with neon, and devoid of any electric connections whatever. The bulb, however, rests within a spiral electric coil. High-frequency currents, pulsing through the coil, supply radiolike energy that lights the gas within. It will be remembered that in a demonstration of short, high-power radio waves, not long ago, neon-filled tubes showed where the electric voltage was the greatest in the air by lighting, without any visible connection.

Today neon is used in such a variety of instruments as high voltage indicators, lightning arresters, and ignition gages. Prof. J. A. Fleming, of London, was the first to use neon in tubes to detect radio waves; now it serves us also in photo-electric or light-sensitive cells, and in television receivers.

A neon lamp can light to full brilliancy and go out completely in a millionth part of a second! That explains the peculiar utility of a neon "glow tube" for furnishing the light in a modern television receiver where, to build up a composite picture of thousands of dots of light, the tube must alternately light and extinguish itself many thousands of times each second.

WHAT further uses will be discovered for neon? One startling possibility is that neon lamps may light tomorrow's homes. Some experts believe that present tungsten-filament lamps, improved as they are over the old-style carbon-filament type, are not the last word in efficiency. Perhaps the next great step forward will be filamentless, glowing tube-shaped lamps patterned after the neon advertising signs, and giving tinted instead of white light.

"Such a lamp," explains Dr. D. Macfarlane Moore, Edison Lamp Works engineer and inventor of the Moore lamp widely used in television receivers, "is particularly efficient because practically its entire radiation is of a monochromatic, or one-color, sort. With the determination of a single color best suited of all to reading or working, a lamp for the home might conceivably be designed to give light of this color alone and waste no energy in other kinds of radiation."

Yellow light, for instance, might serve best. It is unlikely that the red of neon alone would be suitable in the home, but this color might be modified by other substances. Of course lamps of the filamentless type would require special wiring to provide their high-voltage current.

Once a useless rarity—now a precious, valued substance with new uses looking ahead to add to its already varied ones—that is the story of neon, newcomer to industry.

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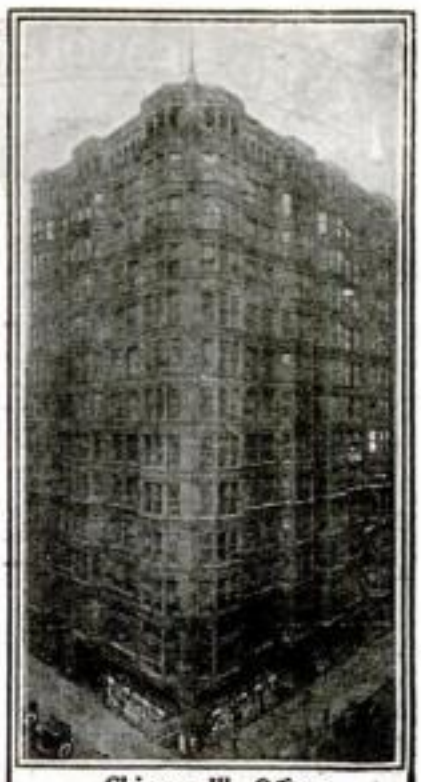

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Shoots His Racing Car at a Target

(*Continued from page 22*)

design for the new car? So the seaplane was recast, so far as outward appearances go, into a land machine designed to house the Napier aerial engine. Irving and his assistants developed the streamline idea until the new car was given a frontal area of just over twelve square feet.

A model of the car was at first constructed, in secret, and wind resistance tested in a tunnel. The model was tested again and again for speed, ability to hold to the course, and general safety. Segrave had previously learned with his *Sunbeam* that a car traveling at a speed of 200 miles an hour or more is best controlled from the center. His measurements were taken and his seat built at the exact center line.

THE Napier 900-horsepower engine rotates at 3,400 revolutions a minute, and the frame is braced with steel tubes of the utmost strength. The steering gear controls the front wheels through a separate mechanism for each. In all, the car weighs five thousand pounds.

The tires are the result of special laboratory research. The probable speed of wheels in the Daytona trials, as Segrave forces the speed up to four miles a minute, will be about 2,500 revolutions a minute. The tire size which was finally decided upon is thirty-seven inches by seven inches.

The car stands only three feet nine inches high; twenty-six feet long, and six feet four inches wide at its widest part. It has a seven-inch ground clearance. The Napier engine is twelve-cylindered, the cylinders spreading fan-wise in three rows of four cylinders each. The valve in the head idea is used, with six overhead cam shafts. The bore is five and a half inches; the stroke five and one eighth inches. With these specifications the Napier engine carried Flight Lieutenant Webster at a recorded speed of 281.5 miles an hour in the *S-5* at Venice. In its tests the *S-5* flew at the tremendous speed of more than three hundred miles an hour.

So much for the motor car that is expected to traverse a mile in fifteen seconds. Men can produce such an annihilator of space, but can man make it do his bidding, and live to discuss his experience? The deviation of one small muscle, the failure or laxity of a complicated system of human nerves, and the result is almost sure disaster.

NO ONE appreciates the human equation in such a test better than Segrave, who was carried along the sands before at 203 miles an hour. His job, as the wheels of his car touch the start of the flying mile, is concentration such as few men are called upon to give. The eye must remain fixed on its goal, never deviating, never blinking.

So Segrave has equipped the new car with rifle sights which will be aimed at a target at the end of the course. This target, an enormous bull's-eye, will be suspended from a wire, strung between two poles or towers thirty feet high. At the front of the hood is set the front sight—the bead of the rifle. The back sight, a telescopic arrangement similar to those on big game guns, is set immediately in front of Segrave. A black band painted on the hood connects the two sights.

As he starts, Segrave will set his sights on the bull's-eye, open his throttle, and with his eye hugging the sight, fire his golden yellow car at the target. As he nears his goal, if he ever does, the target will disappear, for it will hang in the air thirty feet above his line of vision, but almost instantly after it has disappeared, he will have crossed the line. The shot will be fired.

Will Segrave aim straight?

Your First Television Set

(Continued from page 65)

it, reverse the scanning disk and also reverse the direction of rotation of the motor.

There is also the possibility that the image may be reversed. In other words, it will look like the negative film from which prints are made instead of like the print. To get rid of this trouble reverse the wires leading from the radio receiver. Once you have the right combination of disk face and motor rotation for any particular television broadcasting station, you will not have to make any further changes until a change is made in the broadcast apparatus.

ASSUMING that you have the neon tube glowing properly and the disk rotating at just a trifle faster than the required speed, you are ready to receive television images.

Of course the radio receiver must be tuned to the station from which the television broadcasting is to come and you must leave the double-pole, double-throw switch set so that the loudspeaker is connected to the set.

The announcer at the station will make a preliminary announcement which usually includes a statement of what is to be televised. Most of the time this will be a close-up view of a man's face and the subject will smile, laugh, smoke a cigarette or otherwise indicate animated but relatively slow motion. It also is common practice, at some time during the television broadcasting, to hold in front of the transmitter a large call-letters sign.

Of course you will be able to tell when the man's face is upside down, but it is difficult to determine whether it is wrong side to. The letters of the sign will reveal this error.

As soon as the television signals start, throw the switch connecting the radio receiver to the neon tube. The tube will flicker quite visibly. If you cut a photograph into thin horizontal strips and then put the photograph together again, with each strip moved along a fraction of an inch, the whole picture would appear leaning in one direction, and if you moved the strips too far along, the picture would disappear in a meaningless jumble of light and dark areas. This is precisely what happens when the scanning disk departs from the correct speed.

Because television is still in the experimental stage, it is not practical to publish a list of the stations engaged in television broadcasting, but if you desire information on this point or on any of the apparatus used for the work, address your letters: Technical Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York City.

Our A. C. Set Completed

(Continued from page 63)

and a 171A tube in socket *G4*. Then insert the plug of the A-power transformer in the wall socket. In fifteen to forty-five seconds the detector tube, type 227, will heat to operating temperature and you can tune the set.

Screw in the knob on *F2* until the set is in oscillation, and then turn the condenser tuning knob until you hear a whistle that marks the wave from a broadcasting station. With the rotor plates of *D4* loosened, and the plates of *D5* about one quarter engaged, adjust the dial and the rotor of *D4* until the signal is as loud as possible. Then tighten the rotor set screws. If you are troubled with oscillation or squealing, even with the knob of *F2* all the way out, adjust the oscillation controller *H*.

When you wish to tune the short waves, pull the tube out of socket *G2* and transfer the antenna wire from the binding post to which it is attached in Fig. 2, over to the nearest similar binding post on the mounting that holds *A1*, *B1*, *C1*. Then plug in the coil that covers the wave band you desire to receive.

A definite program for getting ahead financially will be found on page four of this issue.

Battles with Polar Ice

(Continued from page 27)

north, east, and west of you." And the ship fettered with chains of ice! Another radio flash! But not from Babushkin. It was the *Krassin* sending word that it had gotten through to the north coast of Spitzbergen and soon would enter the ice.

The next day everything around the ship suddenly creaked and roared! What was the matter? The ice fields surrounding the boat, as far as the eye could reach, were moving in different directions.

Ice-anchors and hawsers were dislodged. Huge masses of ice climbed over the *Malygin*, broke to pieces, plunged into the water, and emerged again. Now open water appeared around the boat, and as suddenly disappeared. Within the ship, cross beams bent and cabin doors warped. Filler and paint flew off the walls in chunks. The ice-breaker was like a house in an earthquake.

ABOUT noon the wind scattered the fog, and Hope Island was sighted only five miles away from the ship!

Now the moving ice carried the boat straight against the island—a new danger.

The engines raced madly, full speed ahead! At first, the ice refused to yield. For half an hour, the ship failed to advance a single yard. Then the frozen wall began to separate slowly! Plowing on desperately, the *Malygin* pushed through. Water spouted in geysers from beneath the screw, and whirlpools seethed all around. Floes several yards long and wide were quickly pulled in and rose to the surface, broken to bits. The blades of the screw struck the ice cakes with continual crashes.

Still, no word from the aviators. In the afternoon of the fourth day, the ship was hemmed in again. Whole mountains of ice piled up against the sides. That night, a brisk wind rose from the north and drove the ship slowly toward a group of icebergs. They faced the *Malygin* like stolid marble monsters. There seemed no chance to avoid them. Again a terrific ice jam made the engines useless.

The crew was on deck. Not a word was spoken. With mingled fear and awe they watched the magnificent sight before them.

BUT the field ice which slowly propelled the *Malygin* happily passed between the icebergs! The fearful danger passed. At last the *Malygin* came to a full stop four miles from the granite island that had threatened it with destruction. There it lay, ice-locked again, for two more days. And still no word from the flyers!

At last, in the dawn of July fourth, while most of the crew were asleep and only the captain and helmsman were on the bridge, a small black spot appeared in the distant sky. It was the plane! Babushkin and his men had suffered untold hardships. For days they had scarcely slept nor eaten, and several times had escaped death by a narrow margin.

These experiences convinced the leaders of the expedition that the *Malygin's* route should be changed. The ship was headed southward to open water and then east, where less ice was expected. Many another hard battle with fog and floes was fought, until finally word came from the *Krassin* by radio that the *Italia's* men had been rescued.

The superb achievement of the *Krassin*, and later the thrilling story of the *Malygin's* adventures, have brought the ice-breaker a measure of public renown. The fact that boats of this type, during the last half century, have virtually built up a new technique of the sea is still, however, little recognized.

For thirty-nine years, the great wooden ice-breaker, the *Bear*, of the U. S. Coast Guard, was Uncle Sam's policeman as well as the only physician, the only hospital, and the only base of food supply north of Nome, Alaska. Some two years ago the veteran ice fighter was succeeded by the modern steel cutter, *Northland*.

Canada, too, uses ice-breakers on the Great Lakes and in the Gulf of St. Lawrence, where four of the ships are on the job each winter. The *Mikua*, which clears the way for shipping in the St. Lawrence, is one of the largest ice-breakers afloat.

Not only in purpose, but also in design, the ice-breaker is different from every other type of craft afloat. It must be both heavy and powerful. Capable of speed sufficient to give it the necessary momentum to break the ice by the sheer force of its blows, it must at the same time be strong enough to inflict, and not suffer, damage by the collision. It must be able to crack ice into pieces weighing a few score tons apiece! And at the same time, it must be capable of sliding on the ice.

The majority of ice-breakers are equipped with large water tanks fore and aft, and in the center. These may be filled or emptied at the rate of several hundred tons an hour, so that the weight can be greatly increased to smash the ice, or to roll the ship in such a manner that it can smash itself free. The ships are provided with steel plating of armor thickness, which sometimes is even doubled fore and aft along the water line and to the bottom of the keel in the fore body, where the ice impact is heaviest.

Today, ice-breakers capable of crushing their way through ice from five to thirty feet thick go to the rescue of ships in distress in all parts of the world. They save human life and costly craft, and are an invaluable aid in increasing humanity's knowledge and wealth.

How to Test Antifreeze

(Continued from page 84)

to insert the hydrometer in the radiator at any time to determine the strength of the solution."

"Not any time," answered Gus. "You forget that a hot solution is expanded and the hydrometer will sink down below where it ought to float. That reading is only good at about sixty degrees."

"Would that reading also apply to that new antifreeze, ethylene glycol?" Dexter asked.

"I should say not!" replied Gus emphatically. "It's good only for a mixture of glycerin and water. Ethylene glycol is just as good as glycerin as an antifreeze, but the pure stuff reads only 1,120, so you'll have to use a hydrometer that reads lower than the storage battery hydrometer to test it when it's thinned with water. Plain water reads 1,000 on the hydrometer scale, you know.

"And if it's alcohol you're trying to test, you'll have to have a hydrometer that reads even below that, because alcohol is lighter than water."

"If glycerin and ethylene glycol do not evaporate as does alcohol, I suppose there's no necessity for testing quite frequently as is the case if you are using alcohol," Dexter observed.

"Depends a lot on how hot your motor runs," Gus explained. "If you don't go spraying the road with expensive cooling solution through a leak, or by boiling it over as you did, and the motor doesn't run so hot that it evaporates a lot of water, you can just squint in the radiator once in a while to make sure that the solution is still there.

"Either glycerin or ethylene glycol will last almost forever if you don't lose 'em through leaks. There's no reason in the world why you shouldn't use the same solution winter after winter, adding a little antifreeze each year to make up for leaks if the hydrometer tells you it's needed."

Magic Tricks Explained

(Continued from page 46)

easily, and by placing one end against the floor, and the other against the lid of the box, force the lid off slowly and noiselessly. The performer escapes and pushes the nails back into the holes. It appears, to the audience, as if he had made a miraculous escape through a knot hole in the box.

Have you ever seen a magician produce a basket of flowers from an "empty" cone? The flowers are artificial, of course, and so cleverly made that they fold flat. Several hundred—enough to fill a bushel basket—can be concealed, or "palmed," in the hand. When they are released by dropping them into the cone, they instantly open and swell out, overflowing the cone. An illustration on page forty-six shows how these flowers are constructed, with green tissue outer leaves, varicolored inner petals, and a small piece of thin watch-spring steel that causes them to open and spread out when released.

A CLEVER trick, depending entirely upon an ingenious mechanical principle, is known as "The Duck Tub." This is a large metal tub, which the magician fills with water after showing that it is apparently empty. A few wooden duck eggs are dropped into the water; a shot is fired, and three or four ducks swim to the surface of the water and jump from the tub!

The tub has a false bottom, consisting of two wide rotatable blades made like electric fan blades except that they are flat. One blade is turned by means of a rope that passes out behind a curtain. When the blades are closed, that is, when they are so turned that no opening is visible between them, the water can be poured into the tub without filling the bottom half. In this lower compartment the live ducks are placed. When the rope is pulled, revolving the blades, the ducks can escape to the surface of the water.

Any story of stage magicians would be incomplete without explaining at least one of the "effects" produced by so-called East Indian fakirs, and occasionally reported by credulous witnesses as "miraculous." It is true that in India one sees many startling, unbelievable feats performed; unfortunately, however, these become exaggerated in story on reaching our shores, so that one must take these miracles with at least a lump of salt. It is a significant fact that Houdini was able to duplicate many of the feats of the fakirs without ascribing the cause to anything more mystical than plain trickery and a knowledge of science and mechanics.

SEVERAL well-known East Indian fakirs are meeting with success in vaudeville with what they call the "buried alive" test. The performer is sealed in a casket, which is buried in a mound of sand or placed on display in full view of the spectators for a certain length of time. The fact that the casket or box is sealed prevents any outside air entering.

Here again the performer falls back on scientific means. He carries his air, in "canned" form, into the casket with him. Several manufacturers produce, for the use of the medical and dental profession, tiny steel drums containing surprising amounts of air in compressed, liquid form. These drums contain sufficient oxygen to keep one alive for a considerable time. They are small enough so that an ingenious performer may conceal several next his body even when dressed in a bathing suit. It is merely necessary to open them slightly, and a supply of fresh, life-giving oxygen continually fills the casket. On the expiration of the period and before the casket has been opened, the performer again conceals the containers, and steps out of the casket before witnesses who invariably pronounce the harassing experiment "genuine."

A definite program for getting ahead financially will be found on page four of this issue.

Must We All Wear Glasses?

(*Continued from page 51*)

slightly from time to time so that objects at different distances can be seen.

Proof that this is so was obtained years ago by a popeyed scientist named Thomas Young, whose eyes had the advantage of sticking out so far that when one of them was turned inward toward his nose it was possible to get a semicircular metal fork, like a miniature pitchfork, in behind it to hold the back of the eyeball rigid. Another fork was then backed up against the eye in front, holding the eyeball tightly between the two. Had changes of focus between near objects and far been accompanied by shortening or lengthening of the eyeball, the clamped eye would have disclosed them. None were found.

What really happens when the focusing is done is that muscles inside the eye pull against the edge of the lens like firemen on a rescue net. This flattens the lens and makes its focus longer. When the muscles relax the elastic lens springs back to its former shape, shortening its focus.

THE ability of one's eye lenses to do this quickly and accurately—the technical name for it is "accommodation"—is not only an essential for doing fine eye work without glasses, but it is probably the best of all measures of youth; not merely of youth in years, but of real vigor and "physiologic youth" of the body. Faces may be lifted or wrinkles cut out. Nothing will hide the telltale age marks in the eye's focusing ability.

The lenses of young people's eyes are soft and elastic. The muscles that stretch them have an easy task. When the tension relaxes the lens thickens instantly. Age causes a slow hardening of these lenses. The muscles cannot change them so easily. That is why people who are old in years, or people whom disease or unhealthful living has made old before their time, have so much difficulty in focusing their eyes for different distances; a difficulty relieved in part by the modern invention of bifocal glasses.

The practical difficulties with precise focusing which account for so many deficiencies of modern eyes begin with this matter of a tendency to focus too close or too far off.

SOMETHING that many mothers do not know is that practically all young babies are far-sighted, like very old men; but for a different reason. When a baby is born the eyeball usually has not made its full growth. It is still too short for its lens system, as though a camera maker had left the box of his camera an inch or two too short. A baby probably sees nothing clearly unless it is at least several feet away. As weeks pass the eyeball lengthens and the focus gradually comes to be normal, so that changes which the muscles make in the flatness or roundness of the lens are able to bring anything into focus. Then for the first time a baby sees clearly his own feet or hands.

Sometimes this normal lengthening of the baby's eyeball after birth goes too far and causes one of the eye troubles most feared by students of our national eyesight, the nearsightedness of school children.

Another possible trouble with eye focus is displacement on one side or the other, like a camera the front of which is bent or pushed to one side. A spectacular instance is the recently reported case of Joseph Rockwitch, of East Rutherford, N. J., a carpenter whose eyes persuaded him to cut off his thumb.

One day Rockwitch unaccountably missed a lath three times in succession with his hatchet. He went to the door for a breath of fresh air, came back and aimed another blow. This time the lath was still safe but an inch of his thumb was gone. A doctor sewed it on again and it grew fast, but the incident required investigation. The trouble, Rockwitch's oculist found, was with his eyes. Now he belongs to the spectacled brigade; his glasses bringing his eyes back to normal from their focusing point a few inches on one side.

MOST important of the defects of eye focus, because commonest among people of youth and early middle age, are the blurring and indistinctness due to a third kind of eye defect, called astigmatism. Such eyes really have a kind of combination of nearsightedness and farsightedness. They are farsighted on two opposite sides and nearsighted on the other two.

This explains why astigmatism is tested with the familiar wagon-wheel chart, its black lines running in different directions across a circle, like the spokes. To an astigmatic eye only one of these spokes, perhaps in one direction, perhaps in another, will be sharply in focus. The one perpendicular to this one will be badly out of focus. The one that is in focus looks black because its image on the sensitive retina of the eye is a sharp one. All the others look gray because their images are blurred.

Perhaps this blurring, which is what always happens when anything that you are trying to see is a little out of focus, might do little harm for most kinds of work, were it not that the eye is always trying to do its best. Its tiny nerves and muscles keep continually readjusting the lens in an impossible effort to get everything right. Furthermore, close concentration on fine eye work makes these muscles hold the lens and the entire eyeball for a long time at a definite focus; something easy enough for the nerveless brass tubes and steel screws of a microscope, but exceedingly tiring for the mobile muscle fibers of the eye.

This tensity required by a fixed focus is probably the chief cause of eyestrain. That is why your eyes seem rested if you can look away from your work once in a while, out of a distant window or at some other object requiring no close focus and no fixed one. That is also the reason for the lessened strain and better productivity of the workers found in the English experiment, where everybody's eyes had been adjusted by glasses so that the natural focus of each eye, when relaxed, was the same as the distance of the work.

Undoubtedly such fixing of the distance of the work to suit the natural focus of the worker's relaxed eye, whether done by special glasses, as in the English experiment, or by adjusting the mutual positions of work and worker, would remove much of the eyestrain of so many modern jobs. Higher or lower chairs for desk workers, for example, are usually easy to provide and are often useful. Also, it is often possible to give the overwilling focusing muscles rest by occasional changes of work during the day, shifting the necessary eye focus from near to far or allowing periods when no precise focus is necessary. Another procedure sometimes beneficial to the eyestrained individual is eye gymnastics, exercises prescribed by the oculist to suit each individual's eyes and to train their muscles for the particular kind of work they need to do.

But foremost of all the eyestrain remedies that science can suggest for factories, offices, or homes, is better light and more of it.

Brighter lighting will not cure absolutely all the ills of everybody's eyes. Oculists and glasses would still be necessary if everybody worked in open daylight and had it twenty-four hours a day. But if more attention were paid to plenty of light in offices, workrooms, and rooms where people read type, fewer of us would be wearing glasses and the British suggestion of a pair of spectacles for every workman would be only a remote possibility.

Lost Races Live Again

(Continued from page 44)

Christian time, year for year, day for day and even hour for hour, was worked out only last year.

Linking the Mayan and Christian calendars back to 600 B. C. with the possible error of about a month, Dr. Sylvanus G. Morley, of the Carnegie Institution of Washington, D. C., predicted in 1922 that the error could be eliminated by resorting to astronomy.

His prediction came true. Dr. Herbert J. Spinden, professor of anthropology at Harvard University, by studying the phases of the planet Venus, which were used by the Mayas for time-fixing purposes, finally wound up the "Mayan Calendar Case" exactly sixty-three years after it was first propounded.

But the detective of archeology does not always succeed in making a capture!

AFTER months of toil Cecil Firth, noted British Egyptologist in charge of excavations at Sakkara, Egypt, last May gained entrance to the tomb in which it was supposed that King Zoser, builder of the famous "step" pyramid, was buried. He found a hollow cavern, in which King Zoser was conspicuous by his absence. Another Egyptologist two years ago found the tomb of Queen Hetepheres, mother of Cheops, builder of the great pyramid; but its sarcophagus was empty.

But often, fortunately, the archeologist's shrewd and patient work is crowned either with the discovery of tangible treasure or of a truth that increases the sum of man's knowledge about himself and his fascinating past.

Through the use of calendars in the form of tree rings, the secret of the age of Pueblo Bonito in Arizona was bared not long ago in one of the most delicately drawn schemes ever to delight the scientific world.

THIS was the question: How long ago did an Indian people live in the big, prehistoric apartment house in Arizona? Log supports found in the ruins gave Dr. Neil M. Judd, director of the National Geographical Society's Pueblo Bonito expedition from 1921 to 1926, a brilliant idea. If he could match rings of the log cross-sections with other logs of known dating, he might fix the age! In collaboration with Dr. A. E. Douglass, another distinguished member of the same exploration party, he traced back the tree calendar through the oldest living trees, and then through the cross-sections of logs in modern pueblos which had been salvaged by the Indians from broken-down Spanish missions. The "investigation," discouraging at times, stretched over a period of six years, but the time is now in sight when it at last may yield the exact year, some ten centuries ago, when the last of the Bonitans fled from their monumental communal home.

In and out of books, on the stage and off, the detective speaks of "sifting the evidence." When he does so, his meaning is, of course, figurative. But the archeologist literally sifts!

More than 100,000 tons of sand and rock from the ruins at Pueblo Bonito were put through the sieve. Howard Carter, the American archeologist, and Lord Carnarvon moved débris shovel by shovel for sixteen years before the ancient Egyptian tomb of Tut-ankh-Amen finally appeared in all its splendor!

The archeological detectives put through screens mounds that once were Ur, one of the most important of the early Babylonian cities, and Nineveh, the renowned ancient capital of the Assyrian Empire, both well known to students of the Bible. Their labors were rewarded by dazzling collections of emeralds, gold beads, carved ivory, and coins.

Talk about mystery and thrills! Is there a keener, finer thrill than that which comes with the solution of riddles from the earliest past—riddles that have baffled the greatest intellects for centuries?

Here Are Correct Answers to Questions on Page 56

1. The formless, foggy clouds known as "stratus" may float as high above sea level as 3,000 feet. Cumulus clouds, that look like masses of cotton wool, average from 4,500 to 6,000 feet high. Cirrus clouds, those isolated feathery white clouds, average 27,000 feet above the earth.

2. The cyclone is a disk of air about 1,000 miles in diameter that revolves horizontally. The hurricane is a cyclone of smaller area with considerably greater vortical action, which makes it more destructive. The tornado is a revolving mass of air approximately 1,000 yards in diameter, which because of its furious vortical motion is extremely destructive.

3. When the air is clear and relatively low in moisture content, blades of grass, stones, and other objects radiate their heat at night faster than heat is radiated to them by the surrounding still air. The temperature of these objects therefore falls below freezing and the moisture in the air congeals into frost on the surfaces of the objects.

4. Dust particles in the air scatter and diffuse light rays, but the effect is more pronounced on the violet, blue, green, and other colors than it is on red. Thus when the air is dry and no moisture forms to balance the effect of dust particles, the sky will look red at sundown, because the dust particles diffuse the other rays and let the red light from the clouds come through to your eyes.

5. Rain is produced by the condensation of water vapor out of the atmosphere on the countless thousands of dust particles always floating in the air. This condensation can occur only when the air is cooled below the dew point. Warm, moist air cools as it rises and expands. When the temperature drops below the dew point rapidly enough, drops of water will form, heavy enough to fall as rain.

6. When light strikes a transparent sphere such as a raindrop, part of it is reflected from the surface and the rest penetrates the surface and is refracted. The refraction spreads the light into its component colors, which you see in the form of a brilliant rainbow.

7. The lines on a weather map are drawn through points where the atmospheric pressures are equal. They are called "isobars." By studying them you can determine the air pressure at various parts of the earth surface, and also predict the probable direction of the wind.

8. The barometer is an instrument that measures atmospheric pressure. A steady rise usually indicates settled fair weather. A slow rise forecasts dry weather with plenty of wind, while a rapid rise indicates clear weather with high winds. A falling barometer indicates wet weather, and if the fall is rapid you may expect wet weather or high winds or both.

9. Halos or rings around either the sun or moon are caused by the refraction of light by enormous numbers of tiny crystals of ice formed high in the upper air.

10. A hygrometer is an instrument that determines the relative amount of water vapor contained in the air, or "relative humidity." There are several varieties, the most common being the wet-and-dry-bulb type. Two thermometers are mounted side by side. The bulb of one is exposed to the air, while the other is covered with fabric kept wet with water from a vessel below. The evaporation of this water cools the fabric covered bulb more than the dry one, so that the thermometers read differently. Since the rate of evaporation depends on the amount of moisture already in the air, the difference in the reading determines the relative humidity.

How to Build a Fireplace

(Continued from page 81)

danger and structural damage through unequal settlement or movement between wood and masonry. In plastering a fireplace or chimney, metal lath is prescribed.

If concrete or field stone is used in constructing your fireplace, a greater thickness of walls is needed than with brick, which is first in ability to withstand heat. Concrete tends to crumble and stones crack with high temperature. These difficulties are overcome to a degree by massive construction, which absorbs surplus heat and allows for interior surface wear. Where the allowable thickness of brick in a fireplace is eight inches, concrete should be twelve inches and stone or rubble masonry sixteen inches. Again, for the chimney above fireplace the flue lining may be cased with a single course of bricks laid flat, but concrete blocks should be thicker or contain metal reinforcement. If the chimney is cast concrete it may be of one brick thickness but needs reinforcement both vertically and horizontally.

CONCRETE will make an effective hearth because of its mass and its insulation from excess heat by ashes. It is commonly used as a base for a top course of fancy bricks with a so-called trimmer arch of brick as the support below. It is feasible to have a reinforced concrete slab, dispensing with arch and brick surface. The concrete top may be marked and colored in brick effect, color being added to the mortar. We must not forget to install an ash dump in the inner hearth, that is, a metal tip-up door that is opened with a poker and lets ashes fall into a pit below. Nor should we take it for granted that the chimney base is always what it should be. The concrete foundations should be at least a foot deep and a foot wider all around than the masonry above. If the chimney is outside the house, foundations must extend below the frost line.

Your fireplace and your chimney are a unit, each so dependent on the other that all the smoky troubles below may be cured by fixing the exit above. A perfect fireplace will misbehave if the chimney top is subjected to down draft by a high ridge or even an overhanging tree. The exit should be not less than three feet above a flat roof or two feet above any ridge or other roof summit. It is also inadvisable to use any sort of chimney hood, especially a kind that reduces the flue area. Hoods of metal and terra cotta seem to be stylish at the present time, but the laws of Nature do not recognize style.

The fireplace screen of course should be large enough to cover the entire opening. Otherwise sparks from a wood fire may fly into the room and cause serious damage. If the mantel is wood it is better to install it at least a foot above the opening.

A ROARING fire is hazardous in the average house. When long flames belch up the chimney from a mass of paper, excelsior, and kindling wood, they may ignite soot within the flue with a discharge of red-hot cinders on the roof. A shingle roof may catch fire, and aside from this danger the flue lining may crack from sudden excessive heat. The chimney should be cleaned every year or two. The modern way is to call up the vacuum cleaner man who comes around with a power machine, long hose, and ladders. He extracts the soot from all flues with neatness and dispatch.

The Patent Office has plenty of inventions to increase the efficiency of fireplaces, but their ultimate value is doubtful. When a fireplace is perfected to the limit it remains a pleasant auxiliary in the battle against cold and not a substitute for a regular house-heating system.

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